ENGINEERING EVALUATION AND COST ANALYSIS
JUNIPER URANIUM MINE
TUOLUMNE COUNTY, CALIFORNIA

Prepared For

U.S. Department of Agriculture
Forest Service
Tahoe National Forest
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ACRONYMS AND ABBREVIATIONS

<	Less than
μg/L	Microgram per liter
μR/hr	Microroentgen per hour
%	Percent
amsl	Above mean sea level
APCD	Air pollution control district
ARAR	Applicable or relevant and appropriate requirement
AWQC	Ambient water quality criteria
bgs	Below ground surface
BJC	Bechtel Jacobs Corporation
$CaCO_3$	Calcium carbonate
CCR	California Code of Regulations
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	Centimeter per second
CNDDB	California Natural Diversity Database
COC	Chemical of concern
COPC	Chemical of potential concern
CSM	Conceptual site model
CWA	Clean Water Act
DO	Dissolved oxygen
DOE	U.S. Department of Energy
EE/CA	Engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
gpm	Gallon per minute
HRS	Hazardous Ranking System
Juniper Mine	Juniper Uranium Mine
LCRS	Leachate collection and recovery system
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
meq/100g	Milliequivalent per 100 gram
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
mil	One thousandth of an inch
mrem/hr	Milliroentgen equivalent man per hour

ACRONYMS AND ABBREVIATIONS (Continued)

NA	Not available
NE	Not exceeded
ND	Not detected
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
O&M	Operation and maintenance
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PA	Preliminary assessment
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
pH	Negative logarithm of the hydrogen ion concentration
PNP	Potential neutralization potential
PRAO	Preliminary response action objective
PRAG	Preliminary response action goal
PRG	Preliminary remediation goal
PVC	Polyvinyl chloride
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity
RWQCB	Regional Water Quality Control Board, Central Valley Region
SAIC	Science Applications International Corporation
SDWA	Safe Drinking Water Act
SI	Site inspection
SMARA	California Surface Mining and Reclamation Act
SMCRA	Surface Mining Control and Reclamation Act
SSL	Soil screening level
STLC	Soluble threshold limit concentration
SWRCB	State Water Resources Control Board
TBC	To be considered
TCRA	Time critical removal action
TDS	Total dissolved solids
Tetra Tech	Tetra Tech, Inc.
TSS	Total suspended solids
USC	United States Code
USFS	U.S. Forest Service
URS	URS Consultants, Inc.
WET	California waste extraction test procedure
WQO	Water quality objective
yd^3	Cubic yard
ZVI	Zero valence iron

EXECUTIVE SUMMARY

The Juniper Uranium Mine (Juniper Mine) is located within the Stanislaus National Forest, Tuolumne County, California. The U.S. Forest Service (USFS) manages the land and mineral rights at Juniper Mine. The USFS is exercising its authority as lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to undertake a response action at Juniper Mine. A preliminary assessment (PA) was conducted by USFS in 1990 and reviewed by a U.S. Environmental Protection Agency (EPA) contractor in 1993. In 1996, a USFS contractor completed a focused site inspection (SI), and in 1999, another USFS contractor conducted a potentially responsible party search. The project administrative record, which contains previous investigation reports, is located at the Forest Supervisors Office, Stanislaus National Forest, Sonora, California.

This engineering evaluation/cost analysis (EE/CA) presents a detailed analysis of response action alternatives that USFS and appropriate regulatory agencies can use for decision-making. The EE/CA identifies, screens, and evaluates technologies that may be implemented to reduce releases of uranium, decay products, and gamma radiation to levels that are not harmful to humans, wildlife, and water quality. Tetra Tech prepared this EE/CA in accordance with the EPA "Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA" (EPA 1993).

Investigations at Juniper Mine include a PA conducted by the USFS, a focused SI conducted by Science Applications International Corporation, and a focused site characterization conducted in 2002 and 2004 by Tetra Tech. Sources of contamination identified at Juniper Mine include the mine pit and waste rock piles. These sources are subject to surface erosion by runoff during storm events. Human health and ecological benchmarks were used to identify chemicals of potential concern (COPC) at Juniper Mine. Benchmarks used or developed include EPA Region IX preliminary remediation goals (PRG), EPA "Soil Screening Guidance for Radionuclides," and Department of Energy and Oak Ridge National Laboratory publications. Human health benchmarks were developed assuming a recreational visitor exposure scenario.

Based on comparison of investigation data to human health and ecological benchmarks; Ra-226 (Ra-226), radium-228 (Ra-228), uranium-234 (U-234), uranium-235 (U-235), uranium-238 (U-238), thorium-228 (Th-228), thorium-230 (Th-230), lead-210 (Pb-210), polonium-210 (Po-210), arsenic, and total uranium have been identified as COPCs in the mine pit and waste rock. Ra-226, U-238, Th-228, Pb-210, arsenic, and thallium were identified as COPCs in sediment hotspots within Pit Creek and Red Rock Creek below

the mine. U-234, U-238, arsenic, manganese, and total uranium were identified as COPCs within Pit Creek and the canyon reach of Red Rock Creek. Ra-226, U-234, U-238, Pb-210, arsenic, and uranium have been identified as COPCs in shallow groundwater emanating from springs within the mine pit. However, the concentrations of Ra-226, U-234, U-238, Pb-210, arsenic, and uranium in the pit spring are similar to the concentrations of these radionuclides and metals in groundwater sampled from a well located up gradient of the mine pit. The radionuclides and metals identified in both the pit spring and up gradient well are present as a result of groundwater contact with naturally occurring radioactive minerals within the ore body. Radon has been identified as a COPC in air based on Residual Radioactivity (RESRAD) modeling. In addition, previous and recent confirmation radiation surveys have documented that gamma radiation emitted from Ra-226 in the Juniper Mine pit, waste rock piles, and creek sediments in Pit Creek and the canyon reach of Red Rock Creek exceed natural background levels of gamma radiation and the EPA-established acceptable excess dose limit of 15 milliroentgen equivalent man (mrem)/year.

In order to determine whether a COPC poses an imminent threat to human health, excess carcinogenic risk was determined for each identified COPC. Identification of an imminent human health hazard was based on a cumulative excess carcinogenic risk greater than one person in ten thousand (1×10^{-4}) that could develop cancer over their lifetime based on the reasonable maximum exposure for an individual. Carcinogenic risk associated with soil and waste rock at the site ranged from 1.81×10^{-5} to 8.89×10^{-3}, while risk from background soil ranged from 1.11×10^{-5} to 3.39×10^{-5}; in all cases Ra-226 was the risk driving chemical of concern (COC). The human health risk screening suggests that a response action is appropriate due to exposure to Ra-226 in the mine pit, Waste Rock Pile No. 1, and Waste Rock Pile No.2; however, risk associated with COPCs in Waste Rock Pile No. 3 do not suggest the need for a response action. Risk associated with sediment at and downstream of the site ranged from 3.01×10^{-5} to 2.18×10^{-4}, while risk from background sediment ranged from 4.85×10^{-6} to 2.62×10^{-5}; in all cases Ra-226 was the risk driving COC. The human health risk screening suggests that a response action is appropriate due to exposure to Ra-226 in sediment hotspots within the outwash area drainages, Pit Creek, and the canyon reach of Red Rock Creek.

Carcinogenic risk associated with surface water discharging from the site ranged from 4.51×10^{-7} to 1.32×10^{-5}, while risk from surface water at a background location was 5.22×10^{-8}; in general uranium, U-234, and U-238 were the risk driving COCs. The concentrations of COCs in surface water within Pit Creek and the canyon reach of Red Rock Creek, while elevated, do not suggest the need for a response action. Risk associated with groundwater water discharging from the site ranged from 4.3×10^{-6} to

4.37×10^{-5}, while risk from groundwater at an up gradient location was 3.86×10^{-5}; in general arsenic, uranium, U-234, U-238, Ra-226, and Pb-210 were the risk driving COCs. The concentrations of COCs in groundwater emanating from the pit spring and a seep at the base of Waste Rock Pile No. 2, while elevated, do not suggest the need for a response action. In addition, radionuclides and metals present in the groundwater emanating from the pit spring results from natural contact with the native ore body. Therefore, treatment of groundwater emanating from the pit spring is not subject to response action under CERCLA 104(a)(3)(A) §9604. If a response action is taken under CERCLA to address COCs in these waters, metals and radionuclides should only be removed to levels equivalent to those found in the pit spring or up gradient groundwater if effluent is discharged to groundwater. If effluent is discharged to surface water, then metals and radionuclides concentrations must attain MCLs.

Carcinogenic risk associated with exposure to gamma radiation at and downstream of the site ranged from 1.35×10^{-5} to 2.81×10^{-1}, while risk from background soil ranged from 3.16×10^{-5} to 9.55×10^{-5}; where Ra-226 was the risk driving COC associated with release of gamma radiation. The human health risk screening suggests that a response action is appropriate due to exposure to gamma radiation in the mine pit, Waste Rock Pile No. 1, Waste Rock Pile No. 2, site roads, and hot spots in outwash area drainages, Pit Creek, and the canyon reach of Red Rock Creek; however, risk associated with gamma radiation from Waste Rock Pile No. 3 and sediments in the meadow and lower meadow reaches of Red Rock creek do not suggest the need for a response action.

Based on the results of the human health and ecological risk screening and RESRAD modeling five preliminary response action objectives (PRAO) were developed for Juniper Mine:

- Reduce risk due to ingestion and inhalation of mine wastes, surface water, groundwater, and sediment to acceptable levels for recreational visitors and terrestrial and aquatic biota
- Reduce risk due to exposure to gamma radiation from the mine pit, waste rock, and sediment to acceptable levels for recreational visitors and terrestrial and aquatic biota
- Minimize air emissions of radon from the mine pit, waste rock, and sediment
- Minimize off-site transport of COCs in surface water, groundwater, sediment, and dust at concentrations that would result in either unacceptable risk to human health and environment or unacceptable degradation of surface and ground water resources
- Protect existing and future beneficial uses of surface and ground waters

A total of six response action alternatives for solid media and two response action alternatives for aqueous media were developed to address these PRAO. The following alternatives were evaluated and compared for effectiveness, implementability, and cost: 1) no action; 2) institutional controls; 3) surface and institutional controls; 4) waste rock and sediment consolidation; 5) waste rock and sediment

consolidation, and earthen cover with geomembrane liner; 6) waste rock and sediment consolidation in mine pit, and construction of engineered drain, liner, and cover; 7) metals removal from surface water, ground water, and leachate using a zero valence iron (ZVI) reactor; and 8) metals removal from surface water, ground water, and leachate using ion exchange. Water treated to background groundwater concentrations would be percolated into the Near Meadow (discharge option 1), percolated into Sardine Meadow (discharge option 2), or discharged to a gallery of shallow infiltration wells (discharge option 3). Alternatively, water treated to federal MCLs would be discharged directly into Pit Creek.

The recommended response action to control exposure to and mobility of contaminants in mine waste and the mine pit at Juniper Mine is excavation of mine waste and consolidation in a repository (Alternative 6) in combination with treatment of groundwater discharging from the under drain using zero valence iron (Alternative 7a), if required. Treatment system effluent would be percolated to groundwater at Near Meadow just north of Waste Rock Pile No.1 (discharge option 1). Alternative 6 involves excavation of all waste rock and sediment hotspots, hauling, and consolidation in the existing mine pit. The waste rock will be placed in an engineered repository consisting of an under drain to control groundwater and an earthen cover with integral geomembrane liner and drainage layer. Surface controls will be used to direct rainwater and snowmelt away from the earthen cover. Institutional controls will be used to restrict site access to ensure cover integrity and permanence. Metals and radionuclides in groundwater discharging from the repository under drain would be treated to local background groundwater concentrations, if necessary, using zero valence iron under Alternative 7a. Treated effluent would be discharged to shallow groundwater in the Near Meadow via below grade percolation trenches (discharge option 1). Institutional controls will be used, if necessary, to limit potential use of groundwater if background water quality in close proximity to the ore body cannot be attained.

Alternative 6 was determined to provide the greatest protection of human health and the environment, compliance with applicable or relevant and appropriate requirements (ARAR), long-term effectiveness and permanence, reduction in mobility, and short-term effectiveness. Alternative 6 is considered most protective of human health and the environment because all wastes would be effectively isolated in an on-site repository, erosion of waste from the mine pit eliminated, and the physical hazard associated with the pit high wall. Leachate generated within the first few years following repository construction and discharged from the repository under drain, will be treated using zero valence iron to local background groundwater concentrations (see Alternative 7a), if required. Treated effluent would be discharge via pipeline to a below grade percolation field located in Near Meadow (discharge option 1), located just north of Waste Rock Pile No.1. Alternative 6 in conjunction with Alternative 7a would meet response

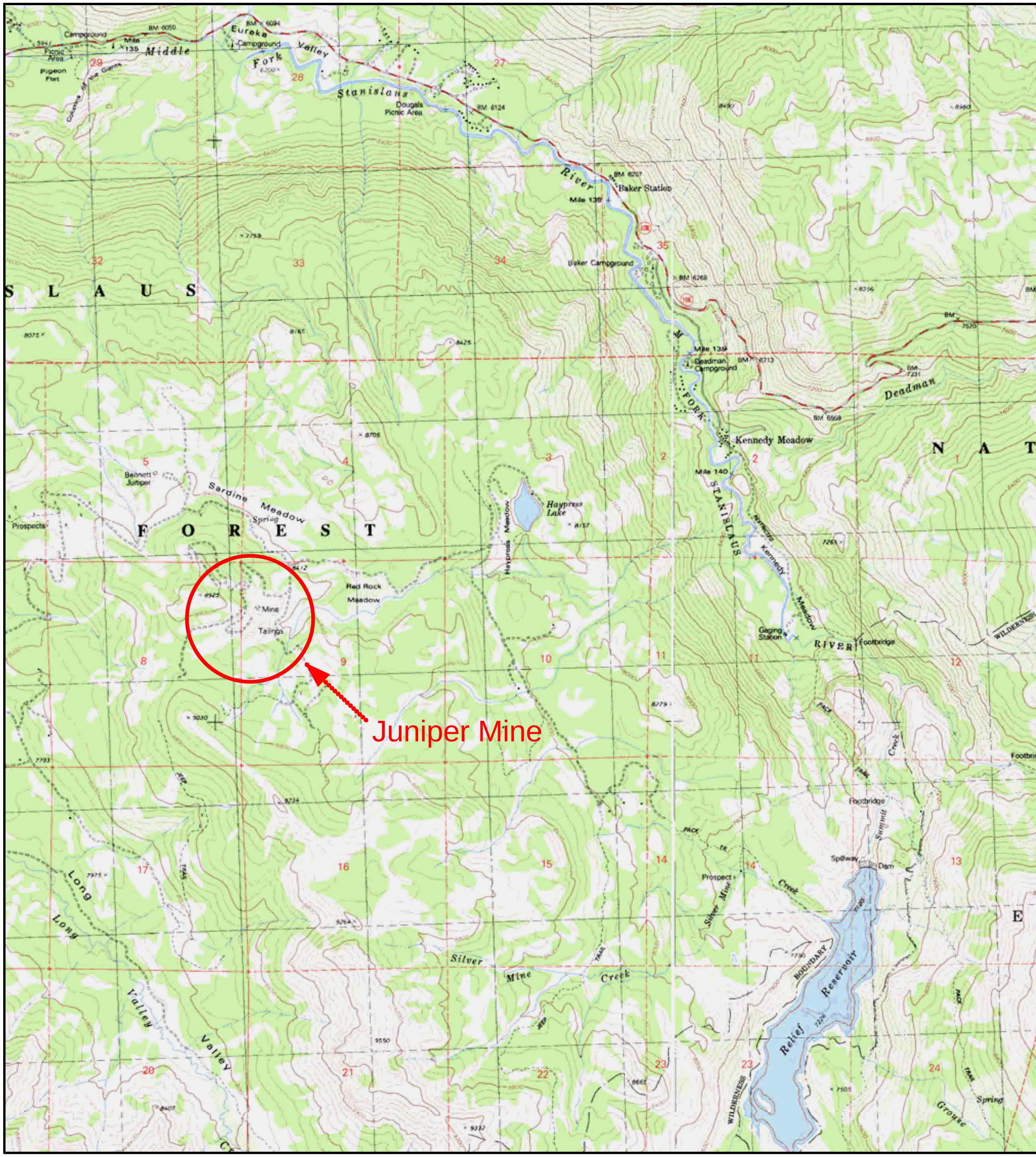
action objectives and comply with ARARs by isolating waste from the environment and treatment of any radionuclides and metals discharged to surface or ground waters. Long-term effectiveness and permanence under Alternative 6 is greater than all other alternatives because the waste is isolated from the environment and water treatment, if required, would meet ARARs. The response action would be implemented during two field seasons (due to snow pack and weather conditions), with operation and maintenance (O&M) activities limited to ensuring success of revegetation efforts, clean out of sediment basins until vegetation is established, and attenuation monitoring. If treatment of leachate is deemed necessary after the first year of construction and monitoring, then a zero valence iron treatment system would be constructed adjacent to the repository under drain outfall. Treatment system O&M activities would include removal and replenishment of spent iron after a five year period and off-site recovery of uranium and recycling of iron. Alternative 6 would be implemented at an estimated cost of $2,387,509, of which $2,215,865 are capital costs and $171,644 are short-term (5 year) O&M costs until vegetation is established. The estimated cost for short-term (5 year) treatment of discharge from the repository under drain using zero valence iron (Alternative 7a) is $669,250. The need for long-term O&M and associated costs will be reevaluated after 5 years of operation.

1.0 INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) is under contract to the U.S. Forest Service (USFS) to conduct a focused site characterization and prepare an engineering evaluation/cost analysis (EE/CA) for the non-time critical removal of uranium and decay products in mine waste at Juniper Uranium Mine (Juniper Mine) located in the Stanislaus National Forest, Tuolumne County, California. The focused site characterization was conducted in September 2002 and June through October 2004 to confirm preliminary assessment (PA)/site inspection (SI) findings, evaluate site risk, evaluate potential degradation of surface water and groundwater quality, and collect data in support of response action alternatives to be evaluated in this EE/CA. This work is being performed in support of their Federal Facilities Compliance Program under Contract No. 53-91SB-00-EE10.

Uranium deposits at the Juniper Mine were discovered in 1955, and between 1956 and 1966, the mine produced an estimated 12,000 tons of ore, from which 45,500 pounds of uranium oxide, were extracted. Uranium ore was transported from the mine to Salt Lake City, Utah for processing. Mining was performed by open pit methods, and the resulting disturbed area consists of about 33 acres. Three waste rock piles, totaling an estimated 278,000 cubic yards (yd^3), are present around the perimeter of the open pit. Operations ceased in 1966 after which time, site activity was limited to exploratory drilling by a succession of mineral developers through 1983 at which time the mine became abandoned. The USFS manages the land and mineral rights at Juniper Mine. Juniper Mine is located off State Highway 108, about 40 miles east of the town of Sonora, California (see Figure 1-1).

The mine is located on land administered by USFS, which has lead agency authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to undertake a response action at Juniper Mine. A PA was conducted by USFS in 1990 and reviewed by a U.S. Environmental Protection Agency (EPA) contractor in 1993. In 1996, a USFS contractor completed a focused SI, and in 1999, another USFS contractor conducted a potentially responsible party search. The PA and focused SI identified sensitive habitats (a meadow and stream) adjacent to the mine site. In 2002, Tetra Tech conducted a focused site characterization to address data gaps identified in the 1996 focused SI. Based on the findings of the 2002 focused site characterization, a Radiological Health Hazard Assessment was prepared which documented the need for a time-critical removal action (TCRA). The TCRA involved construction of a fence around the perimeter of the site to limit site access, installation of signage warning the public about the presence of a radiation hazard, and closure of access roads and the land at and around the mine. The mine access road was closed under Order No. 2003-1 on June 10, 2003



NOT TO SCALE

Notes:

Public Land Survey System Location:
Section 9, T5N, R20E
Mount Diablo Base and Meridian

Topographic Map Source:
USGS Dardanelle and
Sonora Pass 7.5 Minute Quads

N

0 0.5 1 Miles

FIGURE 1-1

SITE LOCATION MAP

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

Tetra Tech EM Inc.

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and the area was closed under Order No. 2003-16 on October 7, 2003. A culvert passing under forest road 5N33 was also replaced and contaminated soil over excavated to reduce public exposure to ionizing radiation. In 2004, Tetra Tech conducted an additional site characterization to address data gaps identified after the 2002 focused site characterization. A sediment detention basin was also constructed on Pit Creek below the mine in 2004 to capture sediment containing elevated concentrations of radionuclides, after observation of a large amount of mobile sediment generated during a summer thunderstorm (see photographs in Appendix C). The project administrative record, which contains previous investigation reports, is located at the Forest Supervisors Office, Stanislaus National Forest, Sonora, California.

Uranium, uranium-thorium decay series daughter products, and gamma radiation are present in or emitted from the mine pit, waste rock piles, and creek sediment at and down gradient of Juniper Mine. Arsenic, radium-226 (Ra-226), radium-228 (Ra-228), uranium-234 (U-234), uranium-235 (U-235), uranium-238 (U-238), thorium-228 (Th-228), thorium-230 (Th-230), lead-210 (Pb-210), polonium-210 (Po-210), and total uranium have been identified as chemicals of potential concern (COPC) in the mine pit and waste rock. These sources may be subject to surface erosion by runoff during storm events. Ra-226, U-238, Th-228, Pb-210, arsenic, and thallium were identified as COPCs in sediment in Pit Creek and Red Rock Creek below the mine. Ra-226, U-234, U-238, Pb-210, arsenic, and uranium have been identified as COPCs in shallow groundwater emanating from springs within the mine pit. However, the concentrations of Ra-226, U-234, U-238, Pb-210, arsenic, and uranium in the pit spring are similar to the concentrations of these radionuclides and metals in groundwater sampled from a well located up gradient of the mine pit. The radionuclides and metals identified in both the pit spring and up gradient well are present as a result of groundwater contact with naturally occurring radioactive minerals within the ore body. Radon has been identified as a potential COPC in air. In addition, previous and recent confirmation radiation surveys have documented that gamma radiation exceeds background levels in the mine pit, on Waste Rock Pile Nos. 1 and 2, and in creek sediment down gradient of the mine.

Because of the complexity of sources and potential exposure pathways, an EE/CA is necessary to identify specific engineering controls that could reduce the migration of uranium and decay products to surface water and sediment downstream of the mine, reduce ingestion and inhalation exposure to uranium and decay products in waste rock, in place ore at the mine, and sediments, and reduce whole body exposure to gamma radiation at and down gradient of the mine.

The purpose of this EE/CA is to present a detailed analysis of response action alternatives that USFS and appropriate regulatory agencies can use for decision-making. This EE/CA will identify, screen, and evaluate technologies that may be implemented to reduce uranium, decay products, and gamma radiation released to levels that are not harmful to humans and wildlife. This EE/CA presents background information, waste characteristics and impacts, applicable or relevant and appropriate requirements (ARAR), preliminary response action objectives and goals, and the development and screening of response action alternatives.

This EE/CA is organized into nine sections. The contents of Sections 2.0 through 9.0 are briefly described below.

Section 2.0, Background - briefly describes the mine location and topography, mine history and features, climate, geology and soils, hydrology and hydrogeology, vegetation and wildlife, significant historical and archeological features, and land use and population.

Section 3.0, Summary of Investigations - summarizes the PA, focused SI, and the recent EE/CA investigation; compares investigation results to human health and ecological benchmarks to identify chemicals of potential concern, and presents a conceptual site model (CSM) for the mine.

Section 4.0, Identification of Imminent Human Health and Ecological Hazards and the Need for a Response Action - identifies human health and ecological hazards and the need for a response action based on the results of human health and ecological risk screening, cumulative excess carcinogenic risk, and threats to the environment

Section 5.0, Applicable or Relevant and Appropriate Requirements - presents the California state and federal chemical-, location-, and action-specific ARARs, which may be applicable for a response action.

Section 6.0, Response Action Objectives And Goals - presents the preliminary response action objectives and goals.

Section 7.0, Identification And Screening of Response Actions, Technology Types, and Process Options - identifies and describes general response actions, technologies, and process options; screens technologies, and develops response action alternatives.

Section 8.0, Detailed Analysis of Response Action Alternatives - presents the detailed analysis of response action alternatives using effectiveness, implementability, and cost criteria.

Section 9.0, Comparative Analysis of Response Action Alternatives - presents a comparative analysis of response action alternatives for consistency with the effectiveness, implementability, and cost criteria; summarizes analysis findings; and presents recommend response action alternative.

2.0 BACKGROUND

This section presents Juniper Mine background information pertinent to the development of an EE/CA. The information presented includes a description of the mine location and topography, mine history and features, climate, geology and soils, hydrology and hydrogeology, vegetation and wildlife, significant historical and archeological features, and land use and population.

2.1 LOCATION AND TOPOGRAPHY

Juniper Mine is located within the boundaries of the Stanislaus National Forest, off State Highway 108, about 40 miles east of the town of Sonora, California (see Figure 1-1). The site is remote and located in rugged terrain, with slope steepness averaging 25 percent. Juniper Mine is located at an elevation of between 8,480 and 8,670 feet above mean sea level (amsl). Geographic coordinates of the Juniper Mine are 38º18'00" north latitude, 119º47'16" west longitude, Section 9, Township 5 North, Range 20 East, Mount Diablo baseline and meridian.

2.2 MINE HISTORY AND FEATURES

Juniper Mine is an abandoned, open-pit uranium mine, with three waste rock piles deposited to the east, north, and south of the pit rim (see Figure 2-1). No underground mine workings or evidence of artifacts supporting underground workings were observed during site visits or review of historic aerial photographs. The preliminary assessment reported that the mine workings encompass about 33 acres; with a combined waste rock pile volume of approximately 278,000 yd^3. No structures or enclosures are located on the mine site. The site is currently fenced. Springs emanate from the mine pit, which feed Pit Creek, a tributary to Red Rock Creek located below the mine. Seeps, which also discharge to Pit Creek, have been identified below the eastern waste rock pile (Waste Rock Pile No.2). A wet meadow is located north of the mine adjacent to the northern waste rock pile (Waste Rock Pile No.1).

Uranium deposits at the Juniper Mine were discovered in 1955, and between 1956 and 1966, the mine produced an estimated 12,000 tons of ore, from which 45,500 pounds of uranium oxide, with an estimated value of $1.6 million, were extracted. Open pit mining appears to have been proceeded by excavation and placement of overburden on slopes south of the pit (Waste Rock Pile No.3); followed by excavation of ore from the top of the ore body and placement of waste rock north of the pit (Waste Rock Pile No.1); and finally excavation of the main ore body and placement of waste rock east of the pit (Waste Rock Pile No.2). Ore processing was not performed on site. Uranium ore was transported from the mine to Salt

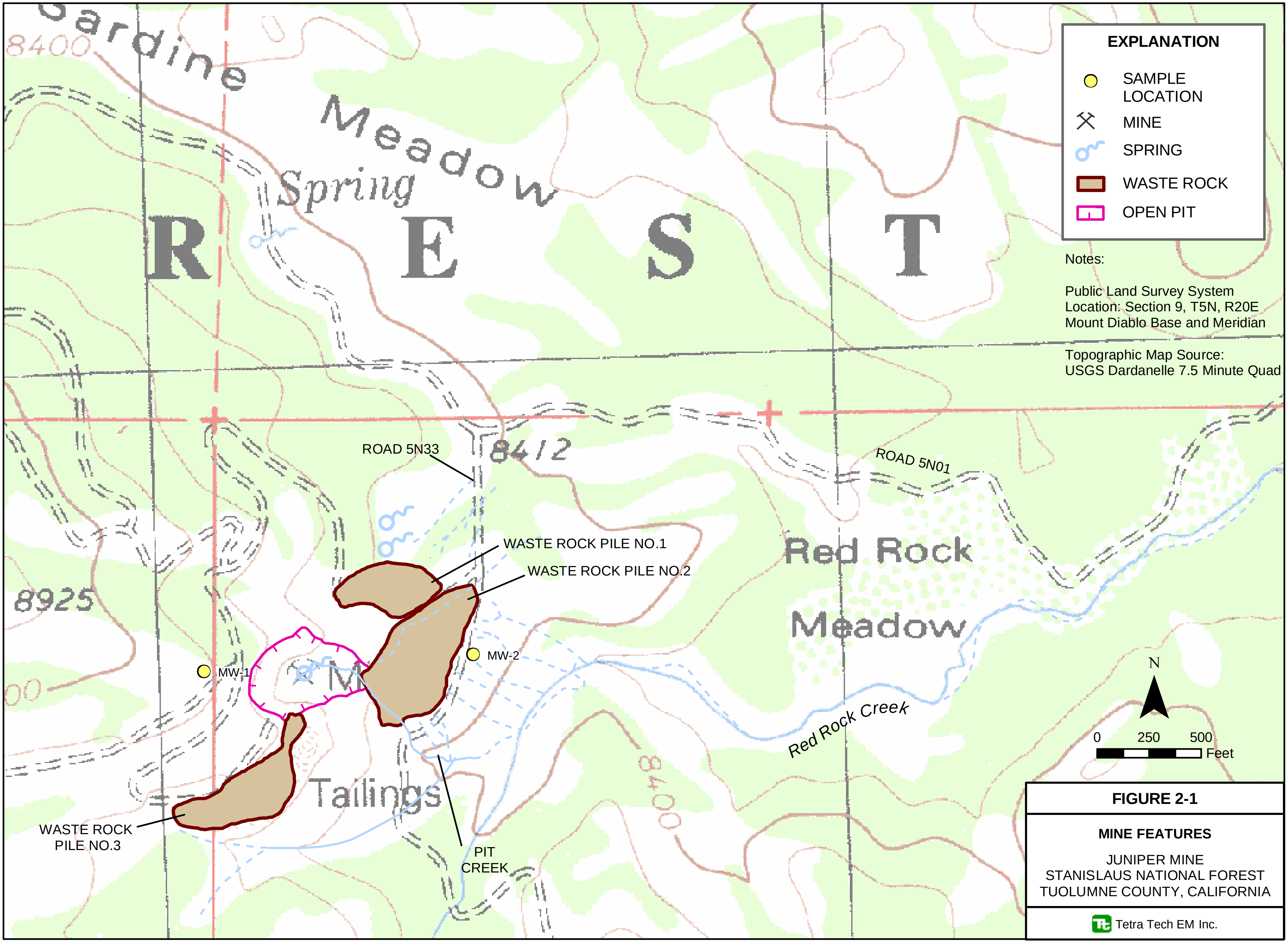

FIGURE 2-1

MINE FEATURES

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

Tetra Tech EM Inc.

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Lake City Utah for processing. The mine is located on land administered by USFS, which has authority under CERCLA to act as the lead agency for Juniper Mine.

During a September 2002 site visit, Tetra Tech surveyed the perimeter and top of slope of the three waste rock piles and the mine pit with a global positioning system, and estimated the bedrock angle of repose beneath the mine site. The perimeter of the northern waste rock pile (No.1) was estimated to be approximately 2.1 acres with an estimated volume of approximately 25,000 yd^3. The perimeter of the eastern waste rock pile (No.2) was estimated to be approximately 4.65 acres with an estimated volume of approximately 169,000 yd^3. The perimeter of the southern waste rock pile (No.3) was estimated to be approximately 3 acres with an estimated volume of approximately 84,000 yd^3.

2.3 CLIMATE

The climate of the Sonora Pass region is characterized by mild spring, summer, and fall months and cold winters. Annual precipitation is from 40 to 60 inches and comes mostly in the form of winter snowfall. The maximum snow pack is generally about 8 feet and does not substantially melt until the early summer months (Rapp 1980). The region is susceptible to summer thunderstorms which generate precipitation rates of 1 to 2 inches per hour. During the SI, the wind was noted to originate from the southwest.

2.4 GEOLOGY AND SOILS

Juniper Mine is located within the Sonora Pass region of the central Sierra Nevada physiographic province. The Miocene Relief Peak Formation underlies the area around Juniper Mine and is the most important potential uranium host rock. Generally, the Relief Peak Formation is a heterogeneous assemblage of andesitic lahar and conglomerate beds, with sporadic andesite breccia flows; however, units of moderately sorted and relatively thin-bedded sedimentary rocks are exposed at the base of the Relief Peak Formation in Juniper Mine (Rapp 1980). At Juniper Mine, uranium mineralization occurs in conglomerate, coarse- and fine-grained sandstone, siltstone, and lithic wacke (USFS 1992). The matrix of the conglomerate is friable, medium- to coarse-grained, lithic sandstone, with some disseminated carbonaceous matter. Because most of the uranium is found in coarse lithology, with almost none in the clay lenses, grain size appears to be an important factor in localizing mineralization (USFS 1992). The principal zone of mineralization is at depths ranging from 170 to 220 feet below former ground surface (pre-mining) (USFS 1992). The upper rhyodacite ash flow tuff sequence of the Valley Springs

Formation, coincident with the pit floor, forms a relatively impermeable layer below the zone of mineralization.

The most likely uranium source rock for uranium mineralization at Juniper Mine and the near vicinity is the Eureka Valley Tuff, a late Miocene latite flow of the Stanislaus Group (Rapp 1980). Uraniferous granite pegmatite dike, exposed in the Dardanelles Cone Quadrangle, also may contribute to secondary uranium mineralization at Juniper Mine (Science Applications International Corporation [SAIC] 1997). Because host rocks for uranium ore at the mine are coarse-grained lithic sandstone, conglomerate, lithic wacke, and lahar of the Relief Peak Formation, SI background soil sampling locations were selected in areas adjacent to exposed deposits typical of the lower portion of the Relief Peak Formation (SAIC 1997).

Soils in the region are very thin and composed of weathered andesitic materials. Soils at the site are described as lithic xerumbrepts and lithic cryumbrepts, or rocky, developing soils, with sand, silt, gravel, and some organic content (USFS 1992).

2.5 HYDROLOGY AND HYDROGEOLOGY

Pit Creek, which flows eastward into Red Rock Creek, is fed by springs upwelling in the mine pit. Red Rock Creek and associated tributaries flow from the southwest to northeast, below the mine. Haypress Lake lies approximately 1.25 miles east northeast of the mine. Haypress Lake discharges to Red Rock Creek, which continues east, before joining the Middle Fork of the Stanislaus River near Kennedy Meadow.

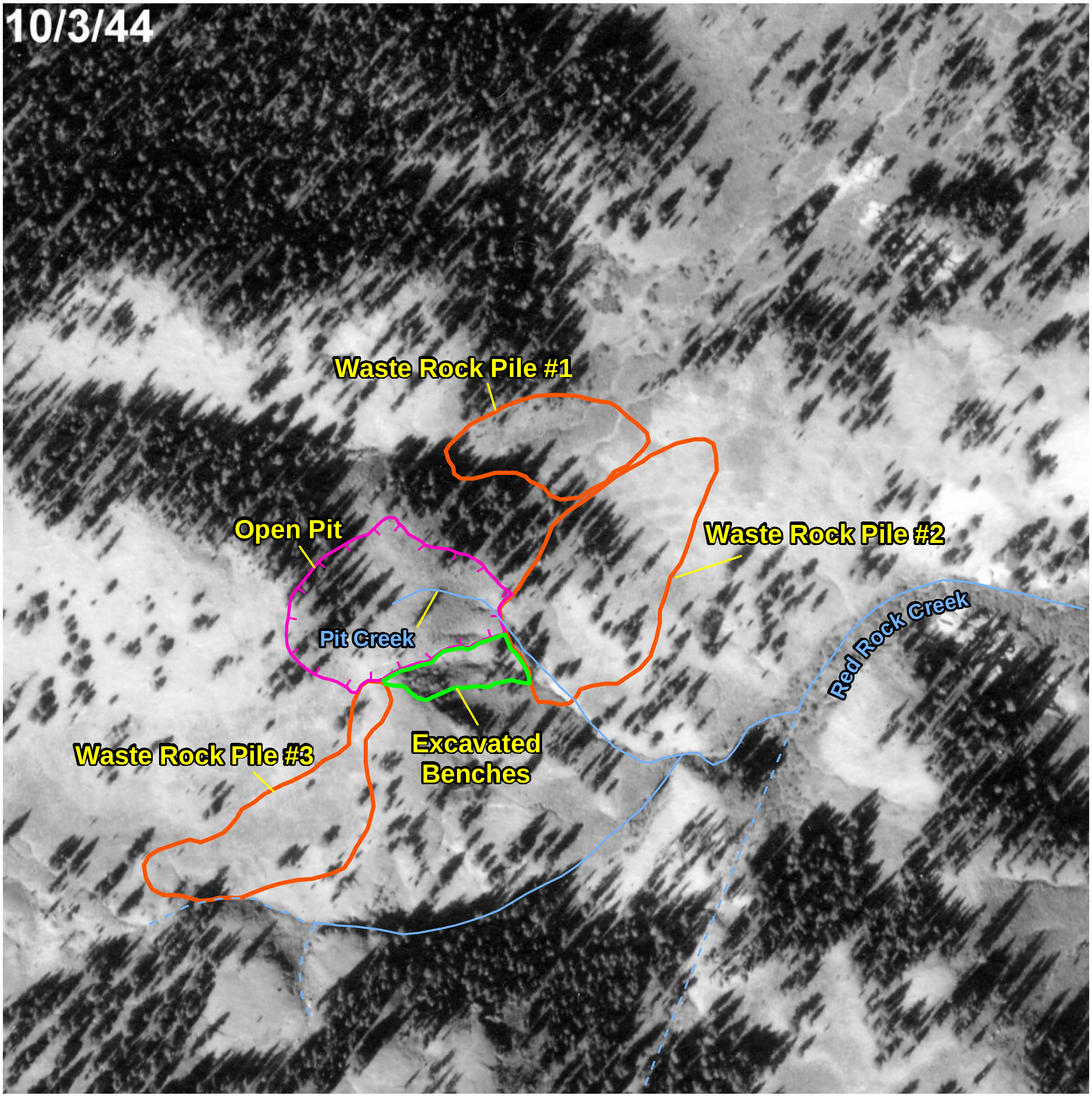
Spring snowmelt was observed in all of these creeks during the June 1996 sampling visit; however, flow was observed to be much lower in Red Rock Creek and was nonexistent in one of the background tributaries during the August sampling visit (SAIC 1997). In September 2002, Tetra Tech observed Pit Creek flowing at 8 to 10 gallons per minute (gpm), Red Rock Creek at the head of Red Rock Meadow flowing at 10 to 15 gpm, and Red Rock Creek at the bottom of Red Rock Meadow flowing at about 30 gpm. In September 2003, USFS observed very high mine waste erosion rates and rapid stream response to a high intensity summer thunderstorm. In July 2004, Tetra Tech observed Red Rock Creek just below the confluence with Pit Creek flowing at about 13 gpm, Red Rock Creek at the bottom of Red Rock Canyon flowing at about 125 gpm, Red Rock Creek in the middle of Red Rock Meadow flowing at about 150 gpm, and Red Rock Creek at the bottom of Red Rock Meadow flowing at about 156 gpm.

Groundwater in the area of the Juniper Mine is found in numerous perched aquifers, some of which discharge from seasonal springs. A historical aerial photograph of the area taken in 1944 shows three or four springs rising from the future location of the mine pit and Waste Rock Pile No.2 (see Figure 2-2). The springs appear to discharge to what is now known as Pit Creek. In addition, springs appear to rise in a meadow from the future location of Waste Rock Pile No.1. Radioactivity (uranium) detected in discharge from these springs and Pit Creek was the likely mechanism for discovery of the buried ore body.

In July 1994, two spring discharges were noted on the floor of the mine pit, another one to the east of the mine, and another above Sardine Meadow, north of the mine (SAIC 1997). In September 2002, Tetra Tech observed the combined discharge of the springs on the floor of the mine pit at approximately 4 to 5 gpm; a seep off of the southern edge of Waste Rock Pile No.2 was discharging to Pit Creek at less than 0.5 gpm. In July 2004, Tetra Tech observed the springs on the floor covered with at least one foot of sediment generated during the September 2003 thunderstorm. The springs were discharging over a diffuse area rather than from point sources. Tetra Tech also observed flow from the seep off of the southern edge of Waste Rock Pile No.2 (less than 0.5 gpm), flow from springs near the toe of Waste Rock Pile No.1 (2 gpm), flow from a line of springs at the head of Sardine Meadow (less than 0.5 gpm), north of the site.

In September 2004, Tetra Tech constructed a background monitoring well up gradient (west) of the mine pit and a down gradient monitoring well east of Waste Rock Pile No.2 (Figure 2-1). The background monitoring well (MW-1) was completed to a depth of 245 feet below ground surface (bgs), just penetrating the rhyodacite tuff underlying the zone of mineralization. Monitoring well MW-1 was screened from 204.5 to 244.5 feet bgs, to ensure capture of perched water bearing zones within the zone of mineralization. Depth of water in monitoring well MW-1 was 189.31 feet bgs (8,549.55 feet amsl) on September 30, 2004. The down gradient monitoring well (MW-2) was completed to a depth of 94 feet bgs, completely penetrating the regional rhyodacite tuff to a depth below the bottom of Red Rock Creek. Uranium mineralization was not present above or within the regional rhyodacite tuff. Monitoring well MW-2 was screened from 50 to 90 feet bgs, the filter pack was extended up to 28 feet bgs to ensure capture of water from fractures in the rhyodacite tuff. Depth of water in monitoring well MW-2 was 8.92 feet bgs (8,449.49 feet amsl) on October 1, 2004.

Based on observation of groundwater elevations in the monitoring wells and the location and elevation of springs; the direction of groundwater flow is toward Red Rock Creek canyon (8,438 to 8,398 feet amsl) to



EXPLANATION

STREAM

Perennial

Intermittent

EXCAVATED BENCHES

OPEN PIT

WASTE ROCK PILE

200 0 200 400 Feet

FIGURE 2-2

HISTORIC HYDROLOGY AND MINE FEATURES

Juniper Mine, Stanislaus National Forest
Tuolumne County, California

Tetra Tech EM Inc.

2003-03-07 U:\juniper_mine\mxd\fig01-03_historical_photo.mxd TtEMI-SA Keith Johnson

the east of the mine. Groundwater discharges from springs along the contact (approximately 8,500 feet amsl) between rhyodacite tuff and the overlying pebble conglomerate. The rate of groundwater flow has not been determined; however, the recharge rate of monitoring well MW-2 is very slow (approximately 0.08 gpm), suggesting limited groundwater flow through fractures in the regional rhyodacite tuff. Finally, groundwater in the immediate vicinity of the mine is depleted on an annual basis (spring and creek discharge trend toward ephemeral).

2.6 VEGETATION AND WILDLIFE

Juniper Mine is located in the Red Fir habitat zone of the Sierra Nevada Range. The dominant species are Noble Fir, White Fir, and Lodgepole Pine. Vegetation in the area consists of a variety of grasses and legumes, wyethia, sagebrush, rabbit ears, skunk cabbage, manzanita, willows, juniper, aspen, oak, fir, cedar, pine, and other trees. The Juniper Mine area is habitat for typical Sierra Nevada bioregion species, including elk, mule deer, coyotes, and mountain lion.

An inventory of plant and wildlife species of special concern has not been compiled for the Juniper Mine area; however, the California Department of Fish and Game Natural Diversity Database (CNDDB) was reviewed for Juniper Mine and surrounding areas. No special status species or habitats are listed in the CNDDB for Juniper Mine or within a 1-mile radius of the mine (CNDDB 2002). No threatened or endangered species have been identified in the area. USFS will complete a biological assessment for those areas subject to a response action that are outside of the footprint of mining activities prior to initiation of construction activities.

2.7 SIGNIFICANT HISTORICAL AND ARCHEOLOGICAL FEATURES

In accordance with the National Historic Preservation Act (NHPA), the Stanislaus National Forest conducted Section 106 studies of the Juniper Mine CERCLA Project in order to determine if any historic properties would be affected by the proposed response action. The area was surveyed for the presence of any archaeological, historic, or cultural sites. Four sites, including Juniper Mine and three lithic scatters, were located within the Area of Potential Effect (APE).

The project proposes to remove the mine tailings by scraping the ground surface and placing the soil back into the mine pit itself. Water will be drawn from the creek for dust abatement procedures. Because

these activities will affect the eligibility of the sites within the APE, per 36 CFR 800.4(c)(1), the four sites were evaluated against the National Register of Historic Places criteria.

None of the sites were found to be eligible for the National Register of Historic Places under criteria A, B, C, or D. Juniper Mine did not meet the 50 years of age threshold or the exception requirement for this criterion. Due to these determinations, the project will have no effect on historic properties. No further work is required.

2.8 LAND USE AND POPULATION

Based on information provided by the USFS, the remote Juniper Mine area is used by recreationists including hikers, campers, hunters, target shooters and off-road vehicle users (including snowmobilers) (USFS 2003b). Because the snow pack does not substantially melt until the early summer months, and because snowfall can limit access to the area at any time during a summer mountain storm, vehicle access to the area is limited to primarily late May through late October, thereby lessening the potential for long-term exposure to gamma radiation, radionuclides, and metals. In addition, there only appears to be five to seven vehicles per day traveling Forest Road 5N01 in the Juniper Mine area and it is estimated that a small percentage of these vehicles may be traveling to Juniper Mine (USFS 2003b). The majority of vehicles are accessing less than a dozen summer cabins located primarily adjacent to Haypress Lake (approximately 1 mile from the site) and the western side of Relief Reservoir (approximately 4 miles from the site); both accessed using Forest Road 5N01 (Figure 2-3). Other private land holdings are located near the mine; however, no cabins have been constructed on these properties. No permanent residents are located within 4 miles of the site (URS Consultants, Inc. [URS] 1993). The Bennett Juniper tree, a popular tourist attraction, is located off of Forest Road 5N01, about 2 miles west of the mine. The widely used Pacific Crest Trail is located approximately 8 miles due east and the Emigrant Wilderness is located approximately 3 miles southeast of the mine.

There are several camping sites within Red Rock Meadow east of the mine, and camping by permit can occur at any location within the forest (USFS 1992). Deer hunting is a common activity in the vicinity of the mine during the mid- to late-summer months. SAIC observed several bow hunters camping near Red Rock Meadow and were hunting throughout the mine area and areas to the east during the 1994 SI (SAIC 1997). Hunters were observed camping during September 2002 within 100 feet of the northern edge of the pit, on a ridge about 1,000 feet southeast of the pit, along Red Rock Creek in Red Rock Meadow and on the margins of Sardine Meadow north of Juniper Mine. The western portion of Waste Rock Pile No. 2

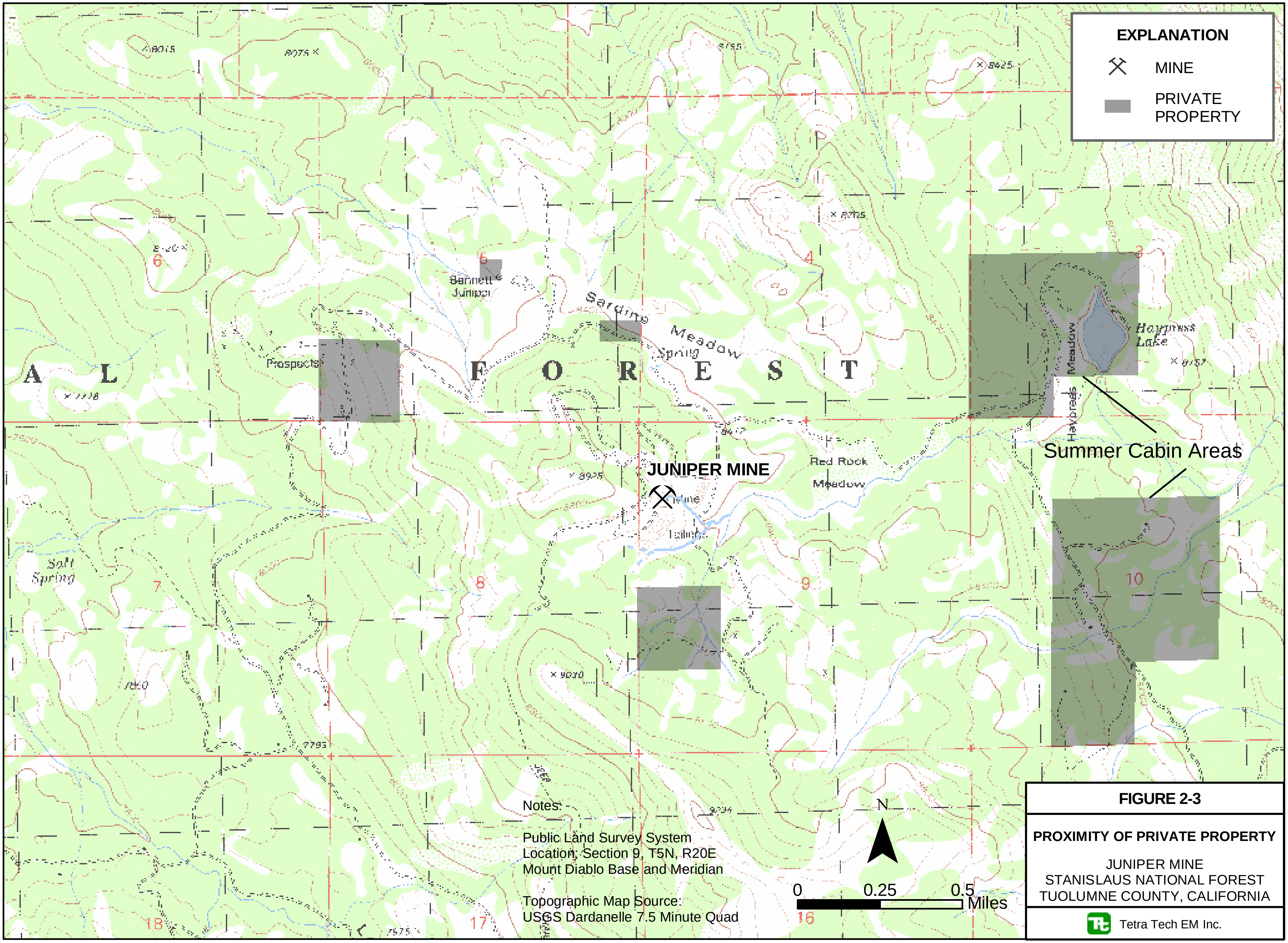


FIGURE 2-3

PROXIMITY OF PRIVATE PROPERTY

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

Tetra Tech EM Inc.

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is apparently used as a place to stand for shooting toward the west wall of the mine pit. The area is littered with numerous shell casings that range from small arms to rifles and shotguns. In addition, several campfire pits and empty beverage containers are also present on the western portion of Waste Rock Pile No. 2. According to the PA, the Middle Fork of the Stanislaus River is considered to be a fishery, receiving stocked fish each year for recreational fishing (USFS 1992; URS 1993).

Cattle tracks and manure are present along Red Rock Creek below the pit and waste rock piles indicating that grazing takes place in the mine area and below it. Although Tetra Tech did not observe any cattle in the area in September 2002, the USFS (2003b) indicates a cattle-grazing allotment for the Sardine Meadow unit consists of 150 cow/calf pairs. The herd is typically pushed into the mine area in late July and remains in the area until September 1. The cattle are not generally located at the mine due to limited forage. Cattle are generally located in Red Rock Creek and tributary southwest of the mine. Salt blocks are used to attract the cows to a given area and prevent overgrazing in a specific area (USFS 2003a).

There are no records of either Pit or Red Rock Creeks being used as a source of drinking water; however it is likely that campers and hikers in the area may consume surface water and groundwater from springs since there are no other designated sources of drinking water in the area. An unimproved camping area approximately 1 mile downstream of the mine along Red Rock Creek is the closest area where surface water could be used for drinking water purposes. Summer cabins are also located within 1 mile of the mine; however, groundwater is the source of drinking water.

3.0 SUMMARY OF INVESTIGATIONS

Investigations at Juniper Mine include a PA conducted by the USFS, a focused SI conducted by SAIC, and EE/CA investigation conducted by Tetra Tech. Sources of contamination identified at Juniper Mine include the mine pit, waste rock piles, creek sediment, and groundwater. Mine ore and wastes are subject to erosion by runoff during storm events. U-234, U-235, U-238, Th-228, Th-230, Ra-226, Ra-228, Pb-210, Po-210, arsenic, and uranium have been identified as COPCs in the mine pit and waste rock. Gamma radiation, U-238, Ra-226, Th-228, Pb-210, arsenic, and thallium were identified as COPC in sediment in Red Rock Creek below the mine. U-234, U-238, Ra-226, Pb-210, arsenic, beryllium, chromium, lead, and uranium were identified as COPC in surface water and ground water. Gamma radiation and radon resulting from the decay of Ra-226 have been identified as a COPC in air.

COPCs were identified based on comparison of investigation data to human health and ecological benchmarks, including EPA Region IX preliminary remediation goals (PRG) for soils (EPA 2004), soil screening levels (SSL) for radionuclides (EPA 2000), maximum contaminant levels (MCL), EPA ambient water quality criteria (AWQC), Residual Radioactivity (RESRAD) computer modeling, and other ecological benchmarks found in the literature. Development of benchmarks used for identification of COPCs to human and ecological receptors is presented in Appendix D.

A summary of the investigations conducted at Juniper Mine, including a comparison of investigation data to human health and ecological benchmarks, and a CSM documenting primary and secondary sources, contaminant release mechanisms, and human health and ecological receptors are presented in the sections below.

3.1 PRELIMINARY ASSESSMENT

A self-directed PA conducted by the USFS in 1990 indicated potential contamination of surface water and soil pathways with metals and radionuclides (USFS 1992).

During the PA, surface water samples were collected in three locations: the mine pit spring (Sample 1A), Pit Creek at the road crossing (Sample 1B), and Red Rock Creek in the lower meadow (Sample 1C). PA sampling locations are presented on Figure 3-1. Samples were analyzed for arsenic, boron, cadmium, iron, lead, mercury, zinc, sulfate, total dissolved solids (TDS), gross alpha radiation, and gross beta radiation. Metals sample results could not be compared to human or ecological benchmark as the samples

were not filtered. Analytical results indicated that contamination concentrations were higher at the two sampling locations closer to the mine than at the location downstream. Gross alpha and beta radiation in water at the mine pit spring and Pit Creek sampling locations exceeded their primary MCLs. Results of the surface water sampling conducted during the PA are presented in Table 3-1.

Based on results of the PA, the USFS confirmed the release of radionuclides to the environment at Juniper Mine. The USFS recommended an SI to evaluate the nature of the release and the risk to human health and the environment.

A federal facility PA review of the Juniper Mine PA was conducted by URS for U.S. Environmental Protection Agency (EPA) Region 9 in August 1993 (URS 1993). The PA review included the following factors as being pertinent to the Hazardous Ranking System (HRS) scoring for the site:

- Tailing piles [actually waste rock piles as there are no mill tailings on site] on site are exposed at the surface and are not covered or contained in any way.
- Contaminants at Juniper Mine may be impacting the habitat of several state and federally protected species [no data to support presence of species].
- There are no permanent residents within 4 miles of the site.

Radioactive components of the PA were not included as HRS factors.

3.2 FOCUSED SITE INSPECTION

USFS contracted SAIC to conduct a focused SI at Juniper Mine in 1994. The purpose of the SI was to establish the presence of on-site and off-site (migrating) contamination associated with metals and radionuclides compared to area background. Environmental samples were collected during a 1994 site reconnaissance visit and a 1996 SI and analyzed to evaluate environmental pathways for contaminant migration, identify potential environmental receptors (humans and wildlife), evaluate the need for additional investigation, and propose response actions (SAIC 1997).

URS conducted a review of the SI sampling plan in August 1995 (URS 1995). The sampling plan review identified several factors as being pertinent to the HRS scoring for the site:

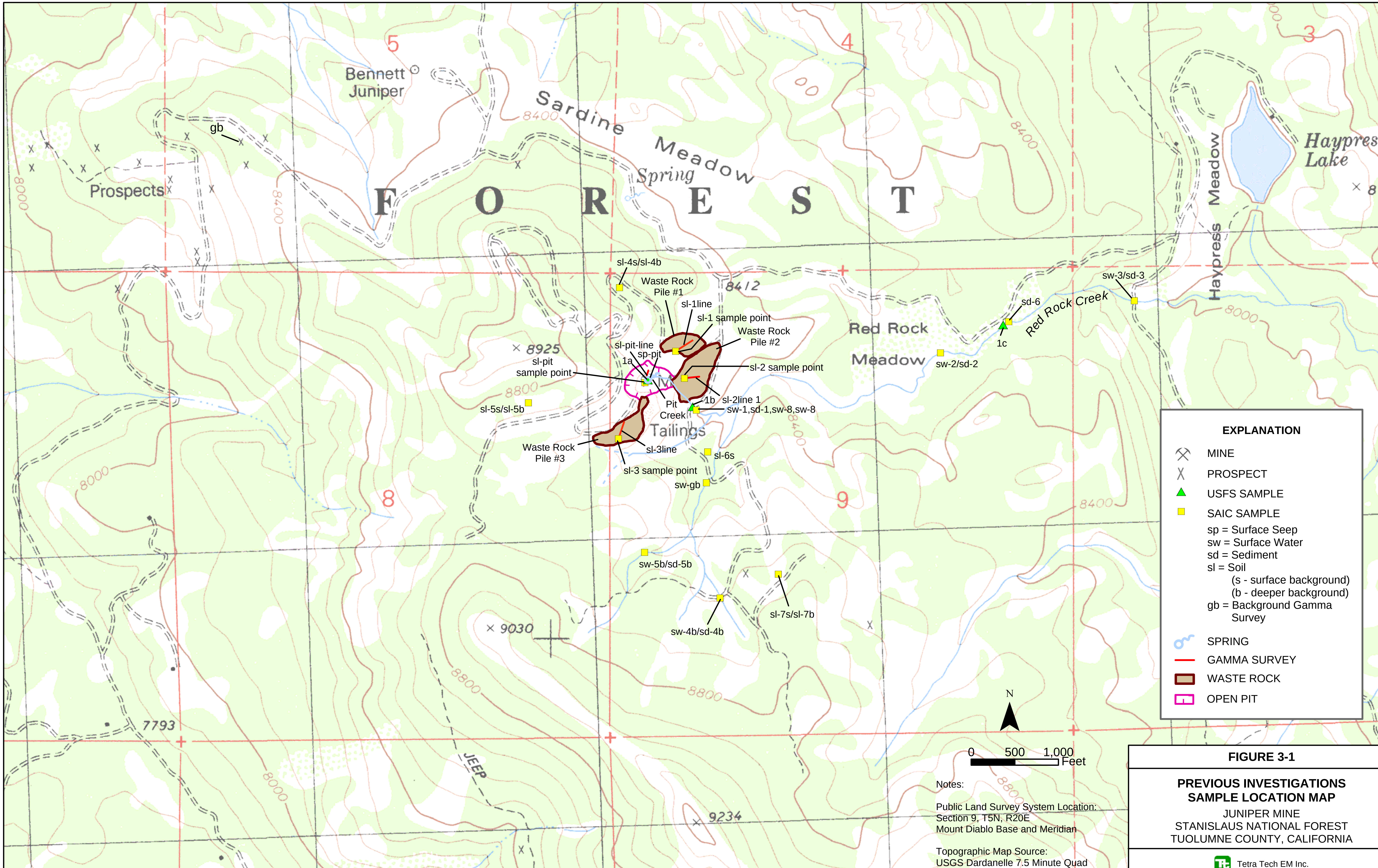
- At least three background samples per matrix must be collected in order to adequately define background concentrations.

- The radionuclides responsible for the gross alpha and beta radiation previously detected must be determined in order to assign the appropriate HRS toxicity values from Appendix B of the Superfund Chemical Data Matrix.
- The appropriate field quality control (QC) samples (field duplicates, matrix spike/matrix spike duplicates) must be collected.
- The HRS targets should be clearly identified (e.g. wetlands at Red Rock Meadow, fisheries). Discussion of these targets must be incorporated into the rationale presented for the number and location of samples. The sampling density is not adequate to assess the impact of run-off from the tailings piles [actually waste rock piles as there are no mill tailings on site] on the surface water and sediment downstream of the mine and Red Rock Meadow. At least one additional sample of both water and sediment is required.

Site Reconnaissance Visit

During the site reconnaissance visit, background radiation measurements were collected on July 28, 1994, about 1 mile northwest of the mine, in the vicinity of other uranium mine claims. Sampling locations are presented on Figure 3-1. Gamma radiation readings ranged from approximately 18 to 475 microroentgens/hour (μR/hr) or 0.018 to 0.475 milliroentgens equivalent man per hour (mrem/hr) assuming a dose quality factor of one (1 roentgen equals 1 roentgen equivalent man). Background ranges from 9 to 37 μR/hr or 0.009 to 0.037 mrem/hr. For comparison, EPA has determined that an excess radiation dose limit of 15 mrem each year is the highest dose that is still protective of the general public. An excess radiation dose is in addition to the approximately 300 mrem (similar to the upper end of the area background value of 324 mrem/year) we all receive naturally each year (EPA 1997). In order to put the EPA 15 mrem excess radiation dose into context, the average chest X-ray provides an excess dose of about 10 mrem.

Three surface water samples were collected during the 1994 site reconnaissance visit; one sample from Pit Creek at the road crossing (SW-1), one sample from the creek at the middle of Red Rock Meadow (SW-2), and one background sample from Red Rock Creek above the confluence with Pit Creek (SW-6B). These samples were analyzed for total and dissolved arsenic, boron, cadmium, calcium, copper, iron, lead, magnesium, mercury, zinc, and gross alpha and beta radiation. The Pit Creek sample (SW-1) showed concentrations of gross alpha radiation above the primary MCL. Dissolved arsenic was detected above the AWQC and dissolved iron above the secondary MCL in the Pit Creek (SW-1) and Red Rock Creek meadow (SW-2) samples. All other constituents were either not detected or were below MCLs and AWQC in surface water.



5
4
3
8
9
Bennett Juniper
Sardine Meadow
Spring
FOREST
Prospects
gb
Haypress Lake
Haypress Meadow
Red Rock Meadow
Red Rock Creek
8400
8000
8800
8412
8925
9030
7793
9234
JEEP
Tailings
sl-4s/sl-4b
Waste Rock Pile #1
sl-1line
sl-1 sample point
Waste Rock Pile #2
sl-pit-line
sp-pit
1a
sl-pit sample point
sl-2 sample point
sl-2line 1
1b
sw-1,sd-1,sw-8,sw-8
Pit Creek
sl-5s/sl-5b
Waste Rock Pile #3
sl-3line
sl-3 sample point
sl-6s
sw-gb
sw-2/sd-2
sd-6
1c
sw-3/sd-3
sw-5b/sd-5b
sw-4b/sd-4b
sl-7s/sl-7b
EXPLANATION
MINE
PROSPECT
USFS SAMPLE
SAIC SAMPLE
sp = Surface Seep
sw = Surface Water
sd = Sediment
sl = Soil
(s - surface background)
(b - deeper background)
gb = Background Gamma Survey
SPRING
GAMMA SURVEY
WASTE ROCK
OPEN PIT
N
0
500
1,000
Feet
Notes:
Public Land Survey System Location:
Section 9, T5N, R20E
Mount Diablo Base and Meridian
Topographic Map Source:
USGS Dardanelle 7.5 Minute Quad
FIGURE 3-1
PREVIOUS INVESTIGATIONS SAMPLE LOCATION MAP
JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA
Tetra Tech EM Inc.

Two ground water samples were also collected during the 1994 site reconnaissance visit. One sample (SP-PIT) was collected from a spring near the inside back of the pit. The other sample (SP-1) was collected from a seep directly below Waste Rock Pile No. 2, adjacent to Pit Creek. These samples were analyzed for total arsenic, boron, cadmium, calcium, copper, iron, lead, magnesium, mercury, zinc, and gross alpha and beta radiation. Gross alpha radiation exceeded primary MCLs in both samples, while the primary MCL for gross beta radiation was exceeded in the pit spring (SP-PIT). Metals sample results could not be compared to human or ecological benchmark as the samples were not filtered. Site reconnaissance water sampling results are presented in Table 3-2.

Site Inspection

During the 1996 SI, a gamma survey was conducted in the mine pit, on each of three waste rock piles, and at a background location about 1 mile northwest of the mine along Forest Road 5N01. Background soil, water, and sediment samples also were collected to determine concentrations of metals and radionuclides in areas that have not been impacted by mining and can be used as a baseline or background comparison to concentrations of metals and radionuclides in areas suspected to be impacted by site mining activities. Site soil, water, and sediment samples were collected from the pit, the waste rock piles, and downstream areas to compare to the background samples and to determine the level of contamination present. SI sampling locations are presented in Figure 3-1.

Thirteen soil samples were analyzed for metals (arsenic, cadmium, calcium, copper, iron, lead, magnesium, uranium, and zinc), Ra-226, cation exchange capacity (CEC), paste pH, acid generation potential, acid-base potential, acid neutralization potential, neutralization potential as calcium carbonate, and percent sulfur. Arsenic was detected in all of the pit and waste rock sample locations at concentrations 1 to 1.5 orders of magnitude above the ecological benchmark and the PRG for recreational exposure (EPA 2004). Arsenic was also detected in a background soil sample north of Waste Rock Pile No. 1 (SL-4S) at concentrations exceeding the ecological benchmark and recreational PRG. Cadmium was detected in all site and background samples at concentrations exceeding the ecological benchmark, though there was not a significant difference between background and site concentrations. Uranium was detected in site soil samples at concentrations 1 to 2 orders of magnitude above the ecological benchmark, with the sample from Waste Rock Pile No.2 exceeding the recreational PRG. Ra-226 was detected in all site and background soil samples ranging from 1 to 4 orders of magnitude above the 0.2 picoCurie per gram (pCi/g) SSL (EPA 2000) and 1 to 1.5 orders of magnitude above the ecological benchmark, with the

highest concentrations occurring at Waste Rock Pile No. 2 (SL-2). Waste Rock Pile No.2 exhibited a paste pH of 3.8 and a slight acid generation potential. SI soil sampling results are presented in Table 3-3.

Seven sediment samples were analyzed for metals (arsenic, cadmium, calcium, copper, iron, lead, magnesium, uranium, and zinc), Ra-226, paste pH, acid generation potential, acid-base potential, acid neutralization potential, neutralization potential as calcium carbonate, and percent sulfur. Arsenic was detected at concentrations within 1 order of magnitude of the sediment benchmark derived from the recreational PRG in Pit Creek (SD-1) and the middle of Red Rock Meadow (SD-2). Cadmium was detected in mine impacted and background sediment at up to 1 order of magnitude above the ecological benchmark, though there was minimal difference between mine impacted and background sediment concentrations. Uranium was detected below the sediment benchmark derived from the recreational PRG in both mine impacted and background locations. Ra-226 concentrations in mine impacted and background sediment samples ranged from 1 to 2 orders of magnitude above the SSL of 0.2 pCi/g. Ra-226 in sediment appears to be decreasing downstream of the site and approaches background levels below Red Rock Meadow. SI sediment sampling results are presented in Table 3-4.

Surface water samples were collected from five locations and analyzed for total and dissolved metals (arsenic, cadmium, calcium, copper, iron, lead, magnesium, uranium, and zinc), Ra-226, gross alpha and beta radiation, sulfate, sulfide, pH, TDS, total suspended solids (TSS), dissolved oxygen (DO), and temperature. With the exception of arsenic, iron, and uranium in one sample (SW-1), all other metals in surface water samples were below MCLs and AWQC. Dissolved arsenic exceeded the AWQC in one sample (Pit Creek at the road crossing [SW-1]). Dissolved iron exceeded the secondary MCL and dissolved uranium exceeded the primary MCL in only one sample (Pit Creek at the road crossing [SW-1]). Unfiltered Ra-226 was detected at concentrations of 34.2 and 27.9 picoCurie per liter (pCi/L) in two samples from Pit Creek at the road crossing (SW-1 and SW-8). Ra-226 concentrations at downstream locations were similar to concentrations at background locations. Gross alpha radiation was detected at about 1 order of magnitude above the MCL (15 pCi/L) surface water collected from Pit Creek at the road. Gross beta radiation was detected slightly above the MCL (50 pCi/L) in Pit Creek. Gross alpha and gross beta radiation was not above their MCLs in Red Rock Creek. SI surface water sampling results are presented in Table 3-2.

During the 1996 SI, a gamma survey was also conducted in the mine pit, the three waste rock piles, and a background location about 1 mile northwest of the mine. The background survey revealed background gamma readings from 9 to 11.5 μR/hr. Levels of gamma radiation surveyed were highest in Waste Rock

Pile No. 2 (135 to 2,000 μR/hr or 0.135 to 2 mrem/hr at ground surface) and in the mine pit (100 to 725 μR/hr or 0.1 to 0.725 mrem/hr at ground surface). For comparison, EPA has determined that an excess radiation dose limit of 15 mrem each year is the highest dose that is still protective of the general public; therefore, a person would receive their yearly excess radiation dose limit within 7.5 hours at Waste Rock Pile No. 2 and 20.7 hours inside the mine pit. Gamma survey results are presented in Table 3-5.

Analytical results from the SI indicated that metals and radionuclides migrated from the mine pit into Pit Creek (SAIC 1997). Based on the results of the SI, SAIC recommended an expanded SI with specific recommendations that include:

- Posting warning signs at the mine to inform recreationalists of the site conditions;
- Collecting water and sediment samples further downstream to determine the extent of contamination;
- Sampling the stream that feeds Sardine Meadow for the constituents found in the seep samples in July 1994 and for Ra-226;
- Updating previous biological information gathered to confirm what ecological receptors may be present.

3.3 EE/CA INVESTIGATION

The purpose of the EE/CA investigation conducted by Tetra Tech was to confirm PA and focused SI findings, identify and collect data to fill data gaps with a minimum number of additional samples, conduct a risk screening evaluation, and support evaluation of response action alternatives to be incorporated in the EE/CA. Surface water, groundwater, and soil sampling, and a gamma survey were conducted in September 2002. Additional surface water, sediment, groundwater, and soil samples were collected and a gamma survey was conducted in July and September 2004 to address data gaps identified after evaluation of data collected in September 2002.

Surface Water

In 2002, surface water samples were collected at two locations: from Pit Creek at the road crossing and from Red Rock Creek at the head of Red Rock Meadow. Sampling locations are presented in Figure 3-2. The surface water samples were analyzed for total arsenic, cadmium, calcium, iron, lead, magnesium, potassium, sodium, thorium, uranium, TDS, TSS, chloride, nitrate, nitrite, orthophosphate, sulfate, total

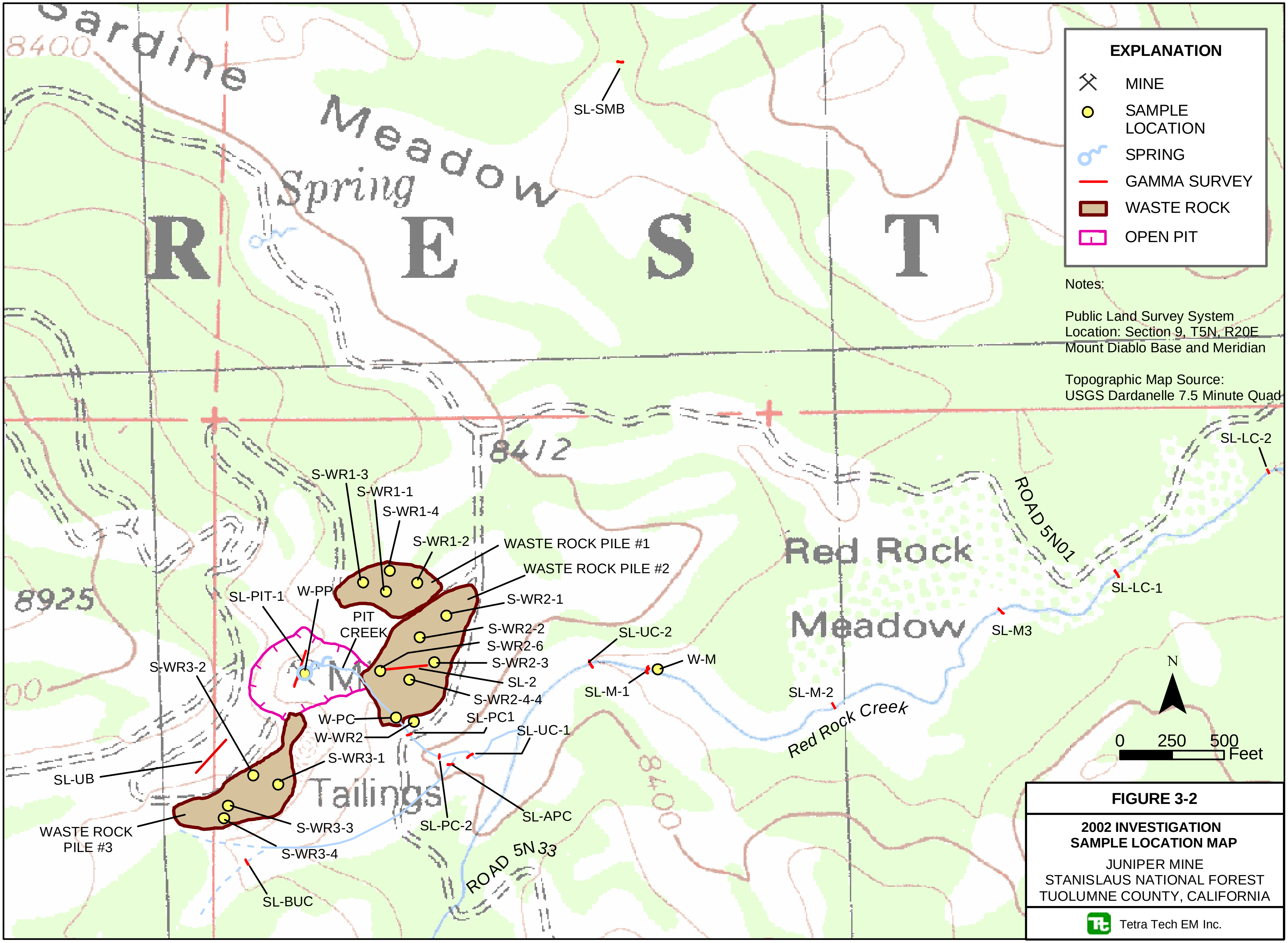


FIGURE 3-2

2002 INVESTIGATION SAMPLE LOCATION MAP

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

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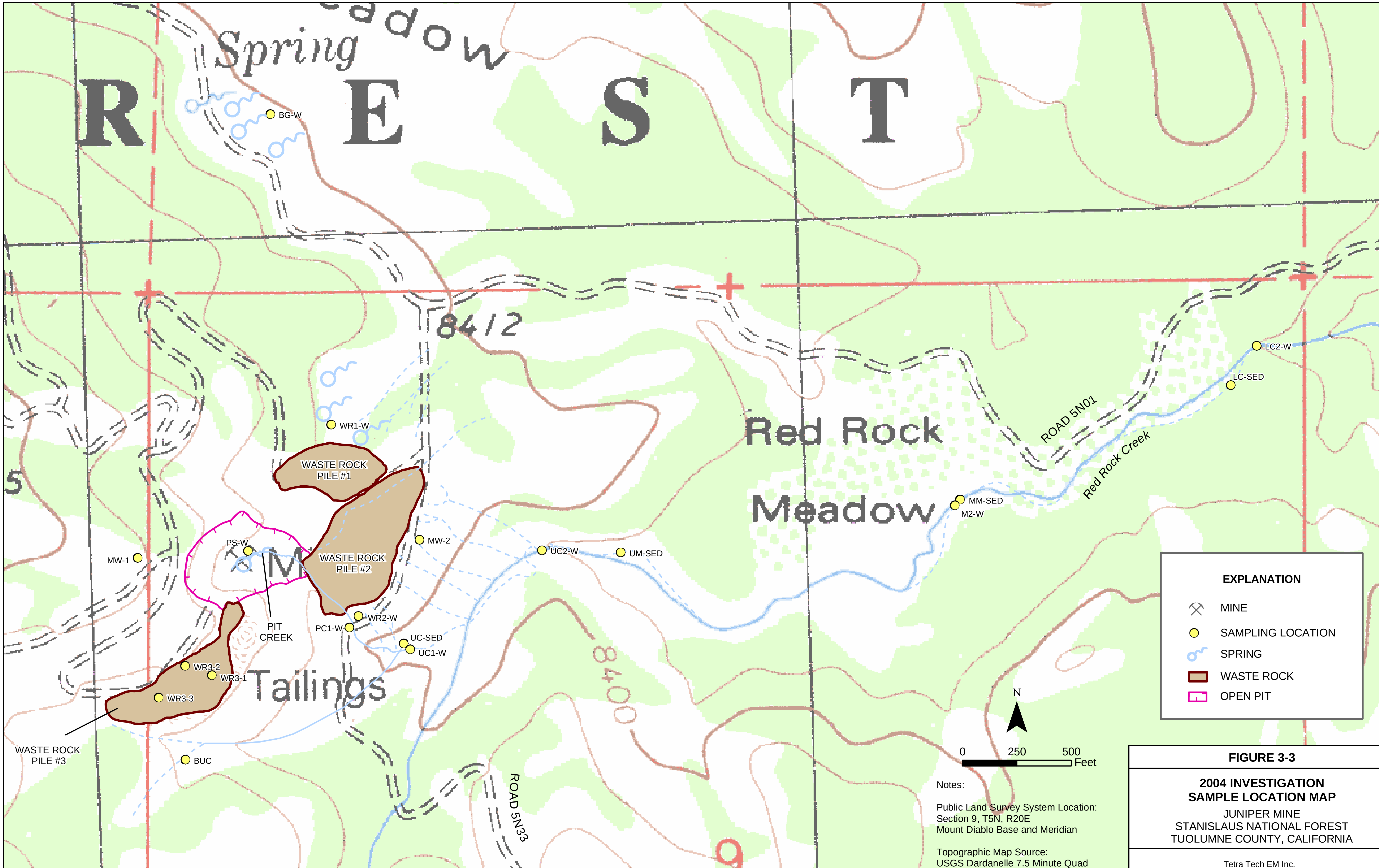
alkalinity, carbonate, hydroxide, and bicarbonate. The field water quality parameters pH, specific conductance, and temperature were also measured. Surface water results for total uranium were 170 microgram per liter (µg/L) in Pit Creek at the road crossing (sample W-PC) and 55 µg/L in the creek at the head of the meadow (sample W-M). Total thorium was detected below the reporting limit in both surface water samples. Surface water was not analyzed for Ra-226. Metals sample results could not be compared to human or ecological benchmark as the samples were not filtered. Surface water sampling results from September 2002 are presented in Table 3-6.

In 2004, surface water samples were collected at six locations: from Pit Creek at the road crossing, the confluence of Pit and Red Rock Creek, at three locations along Red Rock Creek, and a tributary to Red Rock Creek upstream of the mine. Sampling locations are presented in Figure 3-3. The surface water samples were analyzed for dissolved metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, thorium, and uranium); dissolved radionuclides (Ra-226, iso-thorium, iso-uranium, Pb-210, and Po-210); anions (chloride, nitrate, nitrite, orthophosphate, sulfate, total alkalinity, carbonate, hydroxide, and bicarbonate); TDS; and TSS. The field water quality parameters pH, oxidation/reduction potential, specific conductance, temperature, dissolved oxygen, ferrous iron, and flow were also measured. Dissolved arsenic was detected in Pit Creek at the road crossing (PC1) above AWQC and dissolved manganese was detected in the middle of Red Rock meadow (M2) above the secondary MCL. Dissolved uranium and the radionuclides U-234 and U-238 exceeded the primary MCL in Pit Creek at the road crossing (PC1) and at the confluence of Pit and Red Rock creeks (UC1). No other metals, anions, or water quality parameters exceeded water quality criteria. The concentration of metals and radionuclides decrease with distance down Red Rock Creek to concentrations below MCLs by the time surface water reaches the middle of Red Rock Meadow (about ½ mile downstream of the mine). Surface water sampling results from July 2004 are presented in Table 3-9.

<u>Groundwater</u>

In 2002, groundwater samples were collected at two locations: from the mine pit spring and the seep at the base of Waste Rock Pile No. 2 adjacent to Pit Creek. Sampling locations are presented in Figure 3-2. The groundwater samples were analyzed for arsenic, cadmium, calcium, iron, lead, magnesium, potassium, sodium, thorium, uranium, TDS, TSS, chloride, nitrate, nitrite, orthophosphate, sulfate, total alkalinity, carbonate, hydroxide, and bicarbonate. The field water quality parameters pH, specific conductance, and temperature were also measured. Groundwater results for total uranium were 94 µg/L



Spring
Meadow
R E S T
BG-W
8412
5
WR1-W
WASTE ROCK PILE #1
WASTE ROCK PILE #2
PS-W
MW-1
MW-2
UC2-W
UM-SED
M
PIT CREEK
WR2-W
PC1-W
UC-SED
UC1-W
WR3-2
WR3-1
WR3-3
Tailings
WASTE ROCK PILE #3
BUC
8400
ROAD 5N33
Red Rock
Meadow
ROAD 5N01
Red Rock Creek
LC2-W
LC-SED
MM-SED
M2-W
EXPLANATION
MINE
SAMPLING LOCATION
SPRING
WASTE ROCK
OPEN PIT
N
0
250
500
Feet
9
Notes:
Public Land Survey System Location:
Section 9, T5N, R20E
Mount Diablo Base and Meridian
Topographic Map Source:
USGS Dardanelle 7.5 Minute Quad
FIGURE 3-3
2004 INVESTIGATION SAMPLE LOCATION MAP
JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA
Tetra Tech EM Inc.

in the pit spring (W-PP) and 160 μg/L in the seep at the base of Waste Rock Pile No.2 (W-WR2). Total thorium was detected below the reporting limit in both groundwater samples. Metals sample results could not be compared to human or ecological benchmark as the samples were not filtered. Groundwater was not analyzed for Ra-226. Groundwater sampling results from September 2002 are presented in Table 3-6.

In 2004, groundwater samples were collected at six locations: from the mine pit spring, the seep at the base of Waste Rock Pile No. 2 adjacent to Pit Creek, a spring near the toe of Waste Rock Pile No. 1, a spring line at the head of Sardine Meadow, and monitoring wells up and down gradient of the mine. Sampling locations are presented in Figure 3-3. The groundwater samples were analyzed for dissolved metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, thorium, and uranium); dissolved radionuclides (Ra-226, iso-thorium, iso-uranium, Pb-210, and Po-210); anions (chloride, nitrate, nitrite, orthophosphate, sulfate, total alkalinity, carbonate, hydroxide, and bicarbonate); TDS; and TSS. The field water quality parameters pH, oxidation/reduction potential, specific conductance, temperature, dissolved oxygen, ferrous iron, and flow were also measured.

The up gradient well (MW-1) contained the highest levels of dissolved aluminum, arsenic, beryllium, chromium, copper, iron, lead, manganese, and zinc in groundwater likely due to the very turbid (post filtration) sample. Of these dissolved metals, only arsenic, manganese, and zinc were detected above water quality criteria in groundwater samples from other locations. All samples were filtered using a 0.45 micron filter; however, the sample from MW-1 contained colloidal material even after filtration. The up gradient well (MW-1) also contained dissolved uranium, U-234, U-238, Ra-226, and Pb-210 above their respective MCLs. The groundwater discharging from the mine pit spring (PS) contained dissolved arsenic above AWQC and dissolved uranium, U-234, U-238, Ra-226, and Pb-210 above their respective MCLs; however, only Pb-210 (the end daughter product of radioactive decay) exceeded up gradient groundwater concentrations. The discharge from the seep at the base of Waste Rock Pile No. 2 adjacent to Pit Creek (WR2) contained dissolved arsenic above AWQC and dissolved manganese, uranium, U-234, U-238, Ra-226, and Pb-210 above their respective MCLs. The concentration of dissolved uranium, U-234, and U-238 exceed up gradient groundwater concentrations, suggesting that uranium is being actively leached from Waste Rock Pile No.2. Finally, the down gradient well (MW-2) contained dissolved arsenic and zinc above AWQC and dissolved uranium, U-234, and U-238 above their respective MCLs; however, none of these metals exceeded up gradient groundwater concentrations. The impact of the seep at the base of Waste Rock Pile No. 2 (WR2) on down gradient groundwater cannot be readily determined based

on metals and radionuclide concentrations; however, the down gradient well (MW-2) contained the highest concentration of TDS and sulfate and Pit Creek gained dissolved uranium, U-234 and U-238 after passing along the toe of Waste Rock Pile No.2. Groundwater sampling results from July and September 2004 are presented in Table 3-9.

Waste Rock

In 2002, a waste rock sample collected from the Waste Rock Pile No. 2 hot spot (S-WR2) and a composite sample of four grab samples collected from each waste rock pile (S-WR-C) were analyzed for iso-radium, iso-thorium, iso-uranium, Pb-210, lead, thorium, and uranium. Ra-226 was detected at two to three orders of magnitude above the SSL of 0.2 pCi/g and the ecological benchmark in both soil samples. Ra-228 was detected slightly above the SSL of 0.64 pCi/g in both soil samples. Th-228 was detected slightly above the SSL of 0.81 pCi/g in the Waste Rock Pile No.2 hotspot sample (S-WR2). Th-230 was detected at 1 to 1.5 orders of magnitude above the SSL of 60 pCi/g in both soil samples. U-234 was detected above the SSL of 76 pCi/g in the Waste Rock Pile No.2 hotspot sample (S-WR2). U-235 and U-238 were detected at 1 to 2 orders of magnitude above their SSLs of 3.1 and 15 pCi/g, respectively in both samples. Pb-210 was detected 1 to 2 orders of magnitude above the SSL of 5.3 pCi/g in both soil samples. Uranium was detected above the recreational PRG (1,064 milligram per kilogram [mg/kg]) and ecological benchmark in the Waste Rock Pile No. 2 hot spot sample and above the ecological benchmark in the waste rock pile composite sample. Lead and thorium-232 concentrations were below screening criteria in both samples. Waste rock analytical results are presented in Table 3-7.

Composite samples of shallow soil from Waste Rock Pile No. 1 (S-WR1-C), Waste Rock Pile No. 2 (S-WR2-C), and Waste Rock Pile No. 3 (S-WR1-C) were also analyzed for leachable arsenic, cadmium, lead, thorium, and uranium using the waste extraction test procedure with deionized water. Arsenic, cadmium, and lead were below their respective soluble threshold limit concentrations (STLC). Leachate results for uranium ranged from 8.2 μg/L in Waste Rock Pile No. 3 to 120 μg/L in Waste Rock Pile No. 1; only leachate from Waste Rock Pile No. 1 was above the MCL and the pit spring concentration of 94 μg/L. No STLC is available for uranium. Thorium leached from all three samples at concentrations (0.27 to 10 μg/L) exceeding the pit spring concentration of 0.073 μg/L. No STLC is available for thorium. AWQC and MCL criteria are provided for comparative purposes in the absence of STLC for a given metal or radionuclide. Comparison of leachate concentrations to STLC and local groundwater concentrations is used to assess impacts to surface or ground water and to classify mine waste in

accordance with California regulations. Waste rock leachate results from September 2002 are presented in Table 3-7.

In 2004, waste rock samples were collected from three locations (WR3-1, WR3-2, and WR3-3) on Waste Rock Pile No. 3 to evaluate the suitability of the material for use as a cover for consolidated waste rock. Grab samples were collected from multiple depths at each location and combined into a composite sample for each location. The composite samples were analyzed for metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, thorium, and uranium); and radionuclides (Ra-226, iso-thorium, iso-uranium, Pb-210, and Po-210). Arsenic was detected within 1 order of magnitude of the recreational PRG in all three samples. Uranium was detected at the ecological benchmark in all three samples, though at concentrations similar to background locations. Ra-226 was detected at 1 order of magnitude above the SSL of 0.2 pCi/g in all three samples, though at concentrations similar to background locations. Th-228 was detected slightly above the SSL of 0.81 pCi/g in all three samples. Sample WR3-1 was also subject to a California Waste Extraction Test procedure (WET) using deionized water to determine the leachability of metals from the waste rock. The leachate was analyzed for metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, thorium, and uranium); and radionuclides (Ra-226, iso-thorium, iso-uranium, Pb-210, and Po-210). None of the metals in the leachate exceed their respective STLC. AWQC and MCL criteria are provided for comparative purposes in the absence of STLC for a given metal or radionuclide. Waste Rock Pile No.3 soil and leachate analytical results are presented in Table 3-10.

Creek Sediment

Five composite sediment samples were collected from Red Rock Creek at the following locations: Transect UC-3 (UC), Transect M-14 (UM), Transect M-6 (MM), Transect LC-4 (LC), and Transect BUC (a creek tributary upstream of the mine). The composite samples were composed of grab subsamples collected from up to 5 locations and 5 depths (0, 6, 9, 12, and 18 inches bgs) along each creek transect. The composite samples were analyzed for metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, thorium, and uranium); and radionuclides (Ra-226, iso-thorium, iso-uranium, Pb-210, and Po-210).

Arsenic, Ra-226, Th-228, U-238, and Pb-210 were detected above an applicable recreational PRG or SSL for radionuclides. Arsenic was detected within 1 order of magnitude of the recreational PRG in the four samples downstream of the mine, though at concentrations similar to the background location. Ra-226 was detected at 1 order of magnitude above the SSL of 0.2 pCi/g in three of the four locations downstream of the mine and in the background sample location, exceeding the SSL by 2 orders of magnitude in the sample just below the confluence of Pit and Red Rock creeks. Th-228 was detected at 1 order of magnitude above the SSL of 0.81 pCi/g in all sample locations downstream of the mine. U-238 and Pb-210 were detected slightly above their respective SSL of 15 pCi/g and 11 pCi/g in the sample just below the confluence of Pit and Red Rock creeks. No ecological benchmarks were exceeded in the sediment samples.

Sample UC-SED was also subject to a California WET using deionized water to determine the leachability of metals and radionuclides from the creek sediment. The leachate was analyzed for metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, thorium, and uranium); and radionuclides (Ra-226, iso-thorium, iso-uranium, Pb-210, and Po-210). None of the metals in the leachate exceed their respective STLC. AWQC and MCL criteria are provided for comparative purposes in the absence of STLC for a given metal or radionuclide. The radionuclide Pb-210 slightly exceeded the MCL value in the sediment leachate. Creek sediment and leachate analytical results are presented in Table 3-11.

Gamma Radiation Survey

In 2002, A gamma radiation survey was also conducted as part of the EE/CA investigation along 18 survey lines including the mine pit; each of the three waste rock piles; Pit Creek at the road and above Red Rock Creek; Red Rock Creek above and below Pit Creek; Red Rock Creek near the canyon outlet; Red Rock Creek in the upper, middle, and lower meadow; soil background locations above Waste Rock Pile No. 3 and in Sardine Meadow; and a Red Rock Creek tributary background location above Waste Rock Pile No. 3. Survey lines are presented on Figure 3-2. The survey lines on Waste Rock Pile No. 2 (SL-2) and in the mine pit (SL-PIT) were conducted over the same lines surveyed by SAIC during the SI. The background survey revealed gamma readings at the surface from 10 μR/hr or 0.010 mrem/hr at the background transect above Waste Rock Pile No. 3 up to 37 μR/hr or 0.037 mrem/hr at the Sardine Meadow background line. Gamma radiation levels were highest on Waste Rock Pile No. 2 (up to 11,500

μR/hr or 11.5 mrem/hr in the hot spot area) and in the mine pit (up to 6,500 μR/hr or 6.5 mrem/hr near some low grade ore). The gamma radiation data correlated well with those sample locations (Waste Rock Pile No.2 and the mine pit) that contained Ra-226 (gamma emitter) at levels likely to exceed risk screening criteria. For comparison, EPA has determined that an excess radiation dose limit of 15 mrem each year is the highest dose that is still protective of the general public; therefore, a person would receive their yearly excess radiation dose limit within 1.3 hours at the hotspot area on Waste Rock Pile No. 2 and 2.3 hours near the low grade ore inside the mine pit. Gamma survey results are presented in Table 3-8.

In 2004, a gamma radiation survey was also conducted as part of the EE/CA investigation along 50 survey lines including the outwash areas below Waste Rock Pile Nos. 1 and 2, Pit Creek between the road and Red Rock Creek; the canyon reach of Red Rock Creek; the upper, middle, and lower meadow reaches of Red Rock Creek; soil background locations above Waste Rock Pile No.3, in Red Rock Meadow; and in a tributary to Red Rock Creek; and a grid survey of Waste Rock Pile No.2. Survey lines are presented on Figure 3-4.

The background survey locations revealed average gamma readings at the surface from 15.3 to 17.7 μR/hr or 0.015 to 0.017 mrem/hr with a maximum reading of 20 μR/hr or 0.020 mrem/hr. Gamma radiation levels were highest on Waste Rock Pile No. 2 (200 to 1,425 μR/hr or 0.2 to 1.425 mrem/hr with an average of 322.5 μR/hr or 0.323 mrem/hr) exclusive of the hot spot area surveyed in 2002. Sediment deposited in the outwash areas below Waste Rock Pile Nos.1 and 2 exhibited gamma radiation levels ranging from 22 to 90 μR/hr or 0.022 to 0.090 mrem/hr with an average of 26.1 μR/hr or 0.026 mrem/hr. Elevated gamma radiation levels were focused in the drainages below gullies originating from each waste rock pile, where the outwash area below Waste Rock Pile No.2 exhibited levels exceeding the EPA excess dose limit. Gamma radiation levels measured along floodplain transects across Pit and Red Rock creeks indicate that only Pit Creek and the canyon reach of Red Rock Creek exceed the EPA excess dose limit. Sediment within Pit Creek exhibited maximum gamma radiation levels ranging from 49 to 60 μR/hr or 0.049 to 0.06 mrem/hr with an average of 39.1 μR/hr; or 0.039 mrem/hr while sediment within and deposited on the floodplain of the canyon reach of Red Rock Creek exhibited maximum gamma radiation levels ranging from 35 to 50 μR/hr or 0.035 to 0.05 mrem/hr with an average of 33.8 μR/hr or 0.034 mrem/hr. The geographical distribution of gamma radiation, areas above the EPA excess does limit, and associated carcinogenic risk is presented in Figure 3-4. The 2004 gamma radiation data correlated well with 2002 Waste Rock Pile No.2 and 2004 creek sediment sampling locations that

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contained Ra-226 (gamma emitter) at levels likely to exceed risk screening criteria. A summary of gamma survey data are presented in Table 3-12.

Summary

Based on the results of the PA, focused site inspection, and the EE/CA investigation, arsenic, uranium, U-235, U-238, Th-228, and Ra-226 have been identified as COPCs in the mine pit and waste rock. However, the material in Waste Rock Pile No.3 appears to be suitable as cover material for consolidated waste rock based on evaluation of total and leachable metals and radionuclide data. Elevated concentrations of arsenic are likely associated with volcanic rock and soils in the area. Surface water degradation appears to be limited to dissolved arsenic, manganese, uranium, U-234, U-238 in Pit Creek and the canyon reach of Red Rock Creek. The concentration of dissolved arsenic and manganese are similar to and may be attributed to groundwater; however, the concentrations of uranium, U-234, and U-238 discharging from the site exceed up gradient groundwater concentrations. Based on both creek sediment chemical data and gamma radiation survey data, it appears that arsenic, Ra-226, U-238, and Pb-210 have impacted sediment in Pit Creek and the canyon reach of Red Rock Creek, fortunately the data show that Ra-226 and uranium levels are decreasing over time (1996 through 2004). In addition, the metals and radionuclides do not appear to be leaching from sediment to an extent that threatens water quality. Groundwater degradation appears to be limited to dissolved arsenic, manganese, uranium, U-234, U-238, leachable uranium and iso-uranium from Waste Rock Pile No.2, the discharge from which appears to be impacting Pit Creek, and may be impacting down gradient groundwater and the canyon reach of Red Rock Creek. Gamma radiation levels greatly exceeded the EPA excess dose limit on Waste Rock Pile Nos. 1 and 2; while marginally exceeding the excess dose limit in the drainages across the outwash area below Waste Rock Pile No. 2, in Pit Creek sediment, and in sediment and floodplain deposits of the canyon reach of Red Rock Creek. Radon gas resulting from the decay of Ra-226 has been identified as a COPC in air.

3.4 CONCEPTUAL SITE MODEL

This section presents a CSM for Juniper Mine (see Figure 3-5). The CSM identifies seven potential primary sources of mine-related contaminants:

1. Mine Pit – COPCs may be released by storm water runoff, rock-water interaction, slope failure, sediment entrainment/deposition, suspension of particles and dust, and emission of gamma radiation and radon gas.

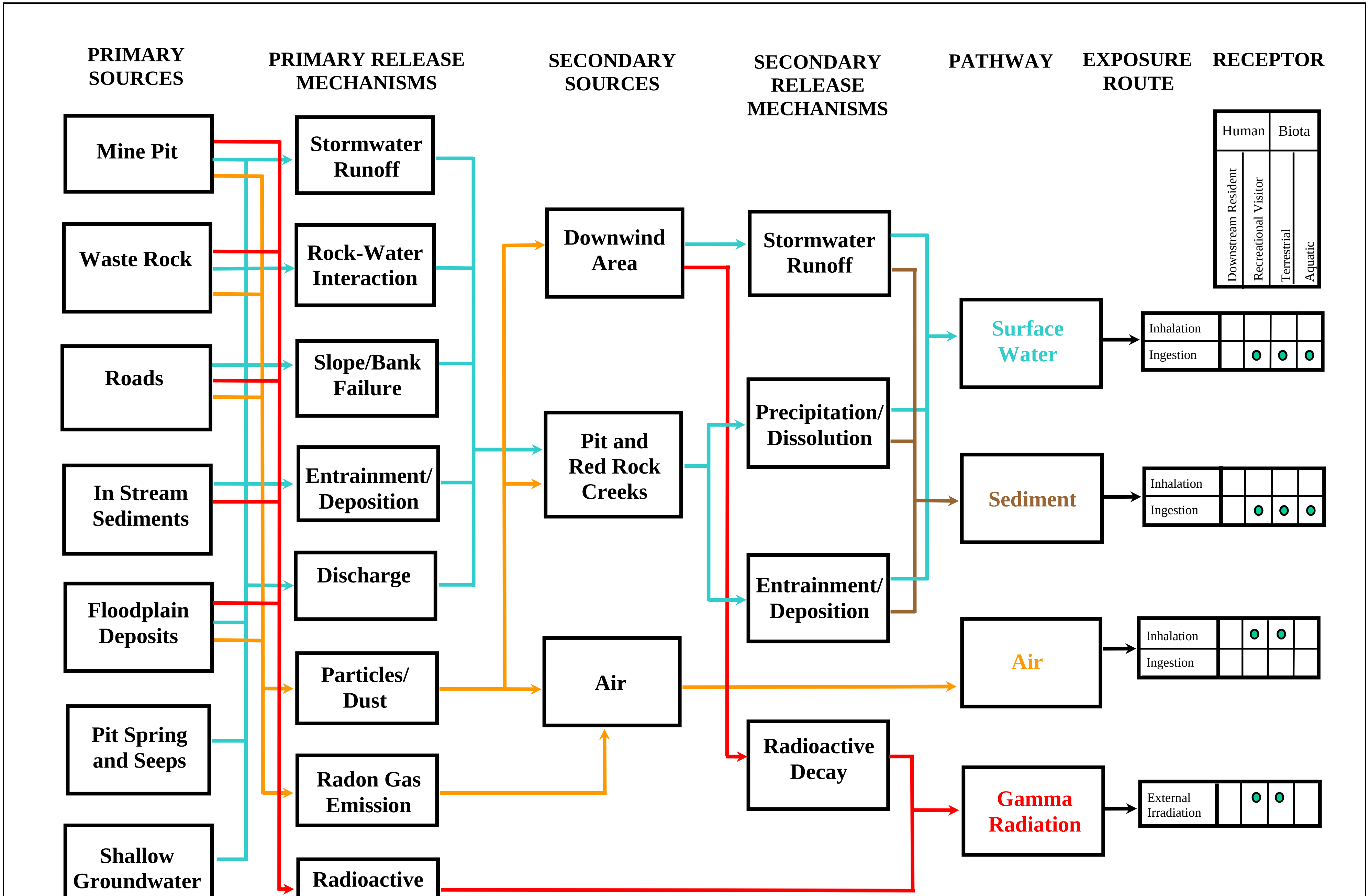

Figure 3-5
Conceptual Site Model
Juniper Mine
Stanislaus National Forest
Tuolumne County, California

2. Waste Rock – COPCs may be released from waste rock by storm water run off, rock-water interaction, slope failure, bank failure along Pit Creek, suspension of particles and dust, and emission of gamma radiation and radon gas.

3. Roads – COPCs may be released from roads cut into waste rock or waste rock used as road cover by storm water run off, rock-water interaction, suspension of particles and dust, and emission of gamma radiation.

4. In Stream Sediments – COPCs contained in Pit Creek and Red Rock Creek sediment may be released through sediment-water interaction and radioactive decay. In addition, sediment in the two creeks may migrate by entrainment/deposition during storm and snow melt events.

5. Floodplain Deposits – COPCs contained in Pit Creek and Red Rock Creek floodplain deposits may be released through entrainment/deposition during high flow events, sediment-water interaction during precipitation and snow melt, bank failure, suspension of particles and dust, and emission of gamma radiation.

6. Pit Springs and Seeps – COPCs may be released from springs within the mine pit by direct discharge. Discharge from the pit springs may also contribute water for entrainment of sediment in Pit Creek, and rock-water interaction in and slope failure along waste rock piles. COPCs may be released from seeps located at the toe of Waste Rock Piles No.1 and No. 2 by direct discharge. Only COPCs exceeding background concentrations in up gradient groundwater are subject to potential response action under CERCLA.

7. Shallow Groundwater – COPCs may be released from shallow groundwater through subsurface flow to Pit and Red Rock creeks. Shallow groundwater may interact with waste rock along the flow path to Pit and Red Rock Creeks. Surface discharge of groundwater from the springs and seeps is addressed in the preceding source description. Ground water in contact with the ore body is a natural occurrence and is not subject to response action under CERCLA 104(a)(3)(A) §9604. Only COPCs exceeding background concentrations in up gradient groundwater are subject to potential response action under CERCLA.

Eight primary mechanisms for release of COPCs to the environment are also identified in the CSM:

1. Stormwater run off that can erode and transport mine waste and floodplain deposits to surface water.
2. Rock-water interactions between mine wastes, intact ore, floodplain deposits and infiltrating rainwater, snowmelt, surface water, and groundwater.
3. Slope/stream bank failure and transport of mine waste and floodplain deposits to surface water.
4. Entrainment/deposition of mine-contaminated sediment in and floodplain deposits along Pit and Red Rock creeks.
5. Discharge of groundwater from springs, discharge of leachate from seeps below mine waste, and discharge of groundwater to Pit and Red Rock creeks.
6. Suspension of particulates containing mine waste in air.
7. Emission of radon gas into the air.

8. Radioactive decay and emission of alpha, beta, and gamma radiation from soil, sediment, floodplain deposits, intact ore, and mine waste.

One or more of the primary release mechanisms may operate on any of the primary sources to mobilize COPCs to the environment at Juniper Mine. However, not every release mechanism is operating at Juniper Mine.

The CSM also identifies three secondary sources of and release mechanisms for COPCs:

1. <u>Downwind Deposition</u> – Dust and particulates blown and deposited downwind of the mine site are potential secondary sources of COPCs. Deposits are subject to storm water runoff to Pit and Red Rock creeks, adding COPCs to the water column and sediment. Alpha, beta, and gamma radiation may also be emitted from the deposits.
2. <u>Pit and Red Rock creeks</u> - Surface water and sediment in the two creeks are secondary sources of COPCs. Precipitates, colloids, and complexes may remove or add COPCs to the water column depending on physical and chemical conditions. Sediment may also add COPCs to the water column through leaching and dissolution. In addition, sediment in the two creeks may migrate by entrainment/deposition during storm and snow melt events.
3. <u>Ambient air</u> - Ambient air also acts as a reservoir for COPCs and is an exposure pathway that does not require a secondary release mechanism. COPCs in air occur on dust and particulates and as radon gas.

An evaluation of environmental data suggests the following scenario regarding the fate and transport of metals and radionuclides at Juniper Mine. Metals and radionuclides contained in low grade ore within the mine pit is entrained by water discharging from the pit springs and is transported from the mine pit via Pit Creek. Metals and radionuclides are also eroded from the toe of Water Rock Pile No.2 as Pit Creek drains from the mine pit. During snowmelt and precipitation events, low grade ore is eroded from the non vegetated pit high wall and steep sides, at times depositing as much as 2 feet of impacted sediment on the pit floor. Snowmelt and runoff from the waste rock piles does not erode as much material due to the unconsolidated nature of the waste material; however, runoff does concentrate flow in large gullies along the edges of the waste rock piles. High runoff velocities in the gullies contribute to headward erosion of the gullies into the waste rock pile and discharge of impacted sediment to drainages to the north and east of the mine. The majority of the impacted sediment discharged from the gullies is deposited near the toes of the waste rock piles and in shallow basins on the outwash area down slope; however, a portion of the sediment has reached and been deposited in the canyon reach of Red Rock Creek.

Metals and radionuclides in surface water and sediment are discharged from the mine pit and waste rock piles to Pit and Red Rock creeks. Once in the creek system, impacted sediment deposits in low gradient

areas such as the canyon reach of Red Rock Creek and oxbows within Red Rock Meadow. Gamma radiation surveys have shown that the floodplain within the canyon reach of Red Rock Creek contains elevated levels of radionuclides. The floodplain surface is reworked each year during spring melt and summer thunderstorm, indicating that impacted sediment is being entrained and redeposited downstream. Fortunately, little impacted sediment has been deposited in Red Rock Meadow.

Interaction of waste rock with infiltrating snowmelt and precipitation and contact with shallow groundwater has lead to the generation of leachate containing metals and radionuclides. The leachate discharges from seeps at the toes of the waste rock piles. The leachate also likely mixes with shallow groundwater and discharges to Pit Creek and the canyon reach of Red Rock Creek. Sediment collected from the canyon reach of Red Rock Creek has also been shown to leach metals and radionuclides though at a level that is not a threat to water quality. Sediment within Pit Creek and on the mine pit floor is likely to leach metals and radionuclides at a level that is a threat to water quality.

Alpha, beta, and gamma radiation is being emitted from low grade ore, waste rock, and sediment both at and down slope from the mine. Alpha and beta radiation are of limited concern due to their limited penetration; however, gamma radiation is of concern due to high energy and degree of penetration. Surveys indicate high levels of gamma radiation within the mine pit and from Waste Rock Pile No.2; moderate levels from Waste Rock Pile No.1; and low levels from the outwash area down slope of Waste Rock Pile No.2 and in sediments in Pit Creek and the canyon reach of Red Rock Creek. Limiting erosion and discharge of sediment from the mine pit and Waste Rock Pile Nos.1 and 2 will reduce the extent of mine waste emitting elevated levels of gamma radiation.

The potential for transport of metals and radionuclides in windborne dust from the mine pit and waste rock piles does exist; however, entrainment of a significant mass of dust during windy conditions has not been observed by USFS, SAIC, or Tetra Tech. These observations are supported by low gamma radiation levels measured on surface soils downwind of the mine. The generation of radon gas during the degradation of Ra-226 is expected primarily within the mine pit and on Waste Rock Pile No.2. The concentration of Ra-226 in surface water, creek sediment, and groundwater is not sufficient to generate radon gas in quantities to likely be of concern. Radon gas is heavier than air and would likely accumulate in the mine pit; limited accumulation is expected on the waste rock piles due to elevated topography.

The CSM identifies four direct exposure media for potential receptors through the ingestion, inhalation and external irradiation exposure pathways for the COPCs:

1. Surface Water - Exposure routes for recreational visitors, terrestrial biota, and aquatic biota include ingestion of water from Pit and Red Rock creeks. Residential receptors were not evaluated due to the long distance to the nearest summer cabins and a very low residual risk beyond Red Rock Meadow.
2. Sediment - Exposure routes for recreational visitors, terrestrial biota, and aquatic biota include ingestion of sediment from Pit and Red Rock creeks. Residential receptors were not evaluated due to the long distance to the nearest summer cabins and a very low residual risk beyond Red Rock Meadow.
3. Air - Exposure routes for recreational visitors and terrestrial biota include inhalation of air and radon gas. Residential receptors were not evaluated due to the long distance to the nearest summer cabins.
4. Gamma Radiation- Exposure routes for recreational visitors, terrestrial biota, and aquatic biota include external irradiation from mine waste, ore body, soils, and sediment. Residential receptors were not evaluated due to long distance to the nearest summer cabins.

The completed pathways shown in the CSM identify the sources, release mechanisms, and media that will be evaluated in human health and ecological risk screening presented in Section 4.0 and potentially addressed by one or more response action alternatives developed in Section 7.0 and evaluated in Section 8.0.

TABLE 3-2
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
SURFACE AND GROUND WATER SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 4)

Sample Number	Sample Location	Sample Date	Total Arsenic (mg/L)	Dissolved Arsenic (mg/L)	Total Boron (mg/L)	Dissolved Boron (mg/L)	Total Cadmium (mg/L)	Dissolved Cadmium (mg/L)	Total Calcium (mg/L)	Dissolved Calcium (mg/L)
SW-1	Pit Creek at road crossing	7/28/1994	0.0079	**0.009**	0.063	0.069	<0.005	<0.005	23	24
		8/19/1996	0.009	**0.005**	NA	NA	0.004	<0.003	35.5	27.9
SW-2	Creek at middle of meadow	7/28/1994	<0.005	**0.0056**	0	0.05	<0.005	<0.005	11.0	10
		8/19/1996	0.001	<0.001	NA	NA	<0.003	0	12.2	12.8
SW-3	Creek below meadow	8/19/1996	<0.001	<0.001	NA	NA	<0.003	<0.003	12.6	12.5
SW-4B	Creek tributary southeast of site (background)	8/19/1996	0.001	<0.001	NA	NA	0.004	<0.003	8.9	6.6
SW-5B	Creek tributary south of site (background)	8/19/1996	<0.001	<0.001	NA	NA	<0.003	<0.003	6.6	6.6
SW-6B	Red Rock Creek, above Pit Creek (background)	7/28/1994	<0.005	NA	0.07	NA	<0.005	NA	6.5	NA
SW-8	Duplicate of SW-1	8/19/1996	0.008	**0.005**	NA	NA	0.006	<0.003	34.4	27.3
SP-1	Seep at base of Waste Rock Pile No.2, adjacent to Pit Creek	7/28/1994	<0.005	NA	0.037	NA	<0.005	NA	47	NA
SP-PIT	Pit spring	7/28/1994	0.0082	NA	0.054	NA	<0.005	NA	8.1	NA
Ambient Water Quality Criteria			--	0.000018	--	--	--	0.0022	--	--
Maximum Contaminant Level[1]			--	0.01[a,b]	--	--	--	0.005[a,b]	--	--

TABLE 3-2
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
SURFACE AND GROUND WATER SAMPLING RESULTS
JUNIPER MINE
(Page 2 of 4)

Sample Number	Sample Location	Sample Date	Total Copper (mg/L)	Dissolved Copper (mg/L)	Total Iron (mg/L)	Dissolved Iron (mg/L)	Total Lead (mg/L)	Dissolved Lead (mg/L)	Total Magnesium (mg/L)	Dissolved Magnesium (mg/L)
SW-1	Pit Creek at road crossing	7/28/1994	<0.01	<0.01	4.3	**0.34**	<0.003	<0.003	23	23
		8/19/1996	0.01	<0.01	9.91	**0.32**	0.004	<0.001	31.4	27.1
SW-2	Creek at middle of meadow	7/28/1994	<0.01	<0.01	0.38	**0.35**	<0.003	<0.003	5.3	5
		8/19/1996	0.01	<0.01	0.39	0.21	0.001	<0.001	7	7.4
SW-3	Creek below meadow	8/19/1996	0.01	<0.01	0.69	0.11	<0.001	<0.001	6.7	6.7
SW-4B	Creek tributary southeast of site (background)	8/19/1996	<0.01	<0.01	5.6	0.2	0.002	<0.001	5.2	4.1
SW-5B	Creek tributary south of site (background)	8/19/1996	<0.01	<0.01	0.18	0.03	<0.001	<0.001	4.1	4.3
SW-6B	Red Rock Creek, above Pit Creek (background)	7/28/1994	<0.01	NA	0.11	NA	<0.003	NA	3.9	NA
SW-8	Duplicate of SW-1	8/19/1996	0.01	<0.01	10.5	0.05	0.005	<0.001	30.9	26.3
SP-1	Seep at base of Waste Rock Pile No.2, adjacent to Pit Creek	7/28/1994	<0.01	NA	0.14	NA	<0.003	NA	14	NA
SP-PIT	Pit spring	7/28/1994	<0.01	NA	<0.1	NA	<0.003	NA	3.2	NA
Ambient Water Quality Criteria			--	0.009	--	0.3	--	0.0025	--	--
Maximum Contaminant Level[1]			--	1[c,d]	--	0.3[c,d]	--	0.015[a,b]	--	--

TABLE 3-2
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
SURFACE AND GROUND WATER SAMPLING RESULTS
JUNIPER MINE
(Page 3 of 4)

Sample Number	Sample Location	Sample Date	Total Mercury (mg/L)	Dissolved Mercury (mg/L)	Total Zinc (mg/L)	Dissolved Zinc (mg/L)	Total Uranium (mg/L)	Dissolved Uranium (mg/L)	Total Radium-226 (pCi/L)	Total Gross Alpha (pCi/L)
SW-1	Pit Creek at road crossing	7/28/1994	<0.0002	NA	<0.02	0.057	NA	NA	NA	**46 +/- 5**
		8/19/1996	NA	NA	0.12	<0.01	0.195	**0.16**	34.2 +/- 1.5	**110 +/- 14**
SW-2	Creek at middle of meadow	7/28/1994	<0.0002	NA	<0.02	<0.02	NA	NA	NA	10 +/-3
		8/19/1996	NA	NA	0.11	0.01	0.0157	0.0163	1.2 +/- 0.3	**15 +/- 4**
SW-3	Creek below meadow	8/19/1996	NA	NA	0.03	<0.01	0.007	0.0066	1 +/-0.3	4 +/- 3
SW-4B	Creek tributary southeast of site (background)	8/19/1996	NA	NA	0.04	<0.01	0.0022	0.0002	1.6 +/- 0.4	4 +/- 3
SW-5B	Creek tributary south of site (background)	8/19/1996	NA	NA	0.02	<0.01	<0.0002	<0.0001	<1	<1
SW-6B	Red Rock Creek, above Pit Creek (background)	7/28/1994	<0.0002	NA	<0.02	NA	NA	NA	NA	4 +/- 2
SW-8	Duplicate of SW-1	8/19/1996	NA	NA	0.05	<0.01	0.196	**0.16**	27.9 +/- 1.4	**130 +/- 14**
SP-1	Seep at base of Waste Rock Pile No.2, adjacent to Pit Creek	7/28/1994	<0.0002	NA	<0.02	NA	NA	NA	NA	**30 +/-4**
SP-PIT	Pit spring	7/28/1994	<0.0002	NA	<0.02	NA	NA	NA	NA	**117 +/- 8**
Ambient Water Quality Criteria			--	0.00077	--	0.12	--	--	--	--
Maximum Contaminant Level[1]			--	0.002[a,b]	--	5[c,d]	--	0.03[b]	--	15[a,b]

TABLE 3-1
U.S. FOREST SERVICE PRELIMINARY ASSESSMENT
SURFACE WATER SAMPLING RESULTS
JUNIPER MINE

Sample Number	Sample Location	Sample Date	Arsenic* (mg/L)	Boron* (mg/L)	Cadmium* (mg/L)	Iron* (mg/L)	Lead* (mg/L)	Mercury* (mg/L)	Zinc* (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Total Alpha (pCi/L)	Total Beta (pCi/L)
1A	Pit spring	7/25/1990	<0.01	<0.1	<0.005	1	<0.01	<0.001	<0.05	231	18	**127.4 +/- 7.2**	**137.5 +/- 20.6**
1B	Pit Creek at the road crossing	7/25/1990	0.024	0.1	<0.005	32.1	<0.01	<0.001	0.11	247	33	**141.7 +/- 8**	**181.8 +/- 21.1**
1C	Red Rock Creek in lower meadow	7/25/1990	<0.01	<0.1	<0.005	0.2	<0.01	<0.001	<0.05	NA	NA	4.3 +/- 1.2	5.1 +/- 4.5
Ambient Water Quality Criteria			--	--	--	--	--	--	--	--	--	--	--
Maximum Contaminant Level[1]			--	--	--	--	--	--	--	500[d]	500[b]	15[a,b]	50[a]

Notes:

Bold indicates values above screening criteria.

* = Assumed to be unfiltered

-- = No standard or standard not applicable to unfiltered water

[1] = Marshack. "A Compilation of Water Quality Goals." August 2000.

[a] = California Department of Health Services Primary MCL

[b] = U.S. EPA Primary MCL

[c] = California Department of Health Services Secondary MCL

[d] = U.S. EPA Secondary MCL

EPA = U.S. Environmental Protection Agency

MCL = Maximum contaminant level

mg/L = Milligram per liter

NA = Not analyzed

ND = Not detected

pCi/L = Picocuries per Liter

TABLE 3-2
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
SURFACE AND GROUND WATER SAMPLING RESULTS
JUNIPER MINE
(Page 4 of 4)

Sample Number	Sample Location	Sample Date	Total Gross Beta (pCi/L)	Sulfate (mg/L)	Sulfide as Sulfur (mg/L)	pH (pH units)	TDS (mg/L)	TSS (mg/L)	Dissolved Oxygen (%)	Temperature (°C)
SW-1	Pit Creek at road crossing	7/28/1994	19 +/-3	18	<0.05	8.3	200	83	NA	NA
		8/19/1996	**70 +/- 6**	20	0.14	8.1	210	84	7.45	13
SW-2	Creek at middle of meadow	7/28/1994	8 +/- 2	NA	NA	8.3	90	12	NA	NA
		8/19/1996	6 +/- 4	<10	<0.02	7.3	90	16	10.08	5
SW-3	Creek below meadow	8/19/1996	<3	10	<0.02	6.9	80	14	9.94	6
SW-4B	Creek tributary southeast of site (background)	8/19/1996	6 +/- 4	<10	0.12	6.7	60	70	7.74	10.5
SW-5B	Creek tributary south of site (background)	8/19/1996	<3	<10	<0.02	6.5	70	<5	8.1	11
SW-6B	Red Rock Creek, above Pit Creek (background)	7/28/1994	<3	NA	NA	7.7	NA	NA	NA	NA
SW-8	Duplicate of SW-1	8/19/1996	**56 +/- 6**	30	0.13	8.1	220	116	7.45	13
SP-1	Seep at base of Waste Rock Pile No.2, adjacent to Pit Creek	7/28/1994	17 +/- 3	NA	NA	7.4	NA	NA	NA	NA
SP-PIT	Pit spring	7/28/1994	**54 +/- 4**	NA	NA	8	NA	NA	NA	NA
Ambient Water Quality Criteria			--	--	--	--	--	--	--	--
Maximum Contaminant Level[1]			50[a]	250[b]	--	6.5 to 8.5[d]	500[d]	--	--	--

TABLE 3-3
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
SOIL SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 1)

Sample Number	Sample Location	Sample Date	Arsenic (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Zinc (mg/kg)	Uranium (mg/kg)	Ra-226 (pCi/g)	Sulfur (%)	Paste pH (pH units)	CEC (meq/100g)	AGP (Ton/kT)	ANP (Ton/kT)	ABP (Ton/kT)	NP $CaCO_3$ (%)	Percent Solids (%)
SL-1	Waste Rock Pile No. 1	8/19/1996	<5	**20**	37,000	<50	41,100	<100	14,000	180	**61**	**78.9 +/- 3.0**	0.1	7.6	15.1	3	46	43	4.6	94.7
SL-2	Waste Rock Pile No. 2	8/20/1996	**116**	**20**	30,000	<50	43,300	<100	7,000	180	**3,170**	**1,750 +/- 21.7**	0.36	3.8	18.9	11	9	-2	0.9	93.2
SL-3	Waste Rock Pile No. 3	8/20/1996	**81**	**20**	32,000	<70	44,100	<100	10,000	240	**18**	**10.1 +/- 1.0**	0.12	6.5	14.4	NA	NA	NA	NA	NA
SL-4B	Background soil north of Waste Rock Pile No. 1 (deep)	6/24/1996	<10	**19**	28,800	40	55,600	<60	8,100	210	4	**5.4 +/- 2.2**	0.01	5.6	22.7	<1	10	10	1	87.2
SL-4S	Background soil north of Waste Rock Pile No. 1 (surface)	6/24/1996	**20**	**9**	26,900	60	53,900	<50	6,400	220	NA	NA	0.01	5.5	23.1	<1	11	11	1.1	96.2
SL-5B	Background Soil west of Waste Rock Pile No. 3 (deep)	6/24/1996	<10	**13**	26,400	30	47,600	<60	11,000	230	4	**5.4 +/- 2.3**	<0.01	5.6	16.3	<1	10	10	1	87.6
SL-5S	Background soil west of Waste Rock Pile No. 3 (surface)	6/24/1996	<10	**14**	28,600	40	44,000	<60	10,600	260	NA	NA	0.02	5.4	22	<1	16	15	1.6	90.3
SL-6B	Background soil above confluence of Pit and Red Rock Meadow Creeks (deep)	6/24/1996	<10	**15**	31,800	<30	48,200	<60	9,100	200	4	**5.4 +/- 2.4**	0.01	6.2	23.2	<1	11	11	1.1	85.9
SL-6S	Background soil above confluence of Pit and Red Rock Meadow Creeks (surface)	6/24/1996	<10	**14**	27,900	<30	44,800	60	7,700	190	NA	NA	0.01	5.6	20.6	<1	11	11	1.1	97
SL-7B	Background soil southeast of mine (deep)	6/24/1996	<10	**18**	29,800	40	55,700	<60	13,600	230	NR	**2.2 +/- 1.8**	0.02	5.5	24.9	<1	14	13	1.4	78.2
SL-7S	Background soil southeast of mine (shallow)	6/24/1996	<30	<20	30,000	<70	58,000	<100	15,000	390	NA	NA	0.02	5.5	26.3	<1	19	18	1.9	75.3
SL-8	Duplicate of SL-1	8/19/1996	**21**	**20**	37,000	<50	42,000	<100	14,000	190	**155**	**65.9 +/- 3.5**	0.12	7.3	15.6	3	51	48	5.1	95.6
SL-PIT	Mine pit	8/20/1996	**44**	<20	46,000	<50	52,100	<100	18,000	250	**720**	**380 +/- 8.2**	0.17	7.3	19.5	NA	NA	NA	NA	NA
PRG			3.04[b]	450[a]	--	41,000[a]	--	150[a]	--	100,000[a]	1,064[b]	--	--	--	--	--	--	--	--	--
SSL (most restrictive)			--	--	--	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--
TTLC[1] (mg/kg)			500	100	--	2,500	--	1,000	--	5,000	--	--	--	--	--	--	--	--	--	--
Ecological Screening Benchmark			9.9[c]	4[c]	--	--	--	--	--	--	5[c]	50[d]	--	--	--	--	--	--	--	--

Notes:

Bold indicates values above screening criteria

1 = If a substance in a waste equals or exceeds the TTLC level, it is considered a hazardous toxic waste

a = Industrial PRG
b = Calculated recreational PRG using site-specific exposure scenario
c = Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al 1997)
d = RAD-BCG, A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE 2002)
-- = No standard
% = Percent
< = Not detected at the limit shown
ABP = Acid-base potential
AGP = Acid generation potential
ANP = Acid neutralization potenital

CEC AG = Cation Exchange Capacity Acid Generation
meq/100g = Milliequivalents per 100 grams
mg/kg = Milligrams per kilogram
NA = Not analyzed
No. = Number
NP $CaCO_3$ = Neutralization potential as calcium carbonate
NR = Not reported
pCi/g = Picocuries per gram
PRG = Preliminary Remediation Goals
Ra = Radium
SSL = Soil screening level from EPA Soil Screening Guidelines for Radionuclides
Ton/kT = Tons $CaCO_3$ per 1,000 tons of sample
TTLC = Total Threshold Limit Concentration

TABLE 3-4
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
SEDIMENT SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 1)

Sample Number	Sample Location	Sample Date	Arsenic (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Zinc (mg/kg)	Uranium (mg/kg)	Ra-226 (pCi/g)	Sulfur (%)	Paste pH (pH units)	AGP (Ton/kT)	ANP (Ton/kT)	ABP (Ton/kT)	NP $CaCO_3$ (%)	Percent Solids (%)
SD-1	Pit Creek at road crossing	8/19/1996	**23**	**40**	51,000	<80	43,300	<200	16,000	240	89	**42.2 +/- 3.4**	0.05	7.7	1	73	72	7.3	65.2
SD-2	Red Rock Creek in middle of meadow	8/19/1996	**16**	**20**	37,000	<70	40,900	<100	8,000	210	37	**9.4 +/- 1.6**	0.03	7.2	<1	30	30	3	75.6
SD-3	Red Rock Creek below meadow	8/19/1996	<5	<20	23,000	<50	23,200	<100	5,000	220	14	**7.4 +/- 1.2**	0.01	7	<1	49	49	4.9	98
SD-4B	Sediment background Red Rock Creek, southeast of mine	8/19/1996	<8	**30**	32,000	<80	43,500	<200	6,000	320	6	**5.2 +/- 1.2**	0.01	6.6	NA	NA	NA	NA	NA
SD-5B	Sediment background Red Rock Creek, south of mine	8/19/1996	<7	<20	28,000	<70	36,100	<100	4,000	190	<3.49	**4.0 +/- 1.1**	<0.01	6.7	<1	15	15	1.5	71.7
SD-6	Sediment Red Rock Creek in lower meadow	8/19/1996	<7	**20**	27,000	<70	31,900	100	4,000	180	11	**10.0 +/- 1.8**	0.01	6.6	<1	16	16	1.6	73.1
SD-8	Duplicate of SD-1	8/19/1996	**13**	<20	56,000	<70	41,700	100	16,000	220	94	**43.0 +/- 3.1**	0.04	7.6	1	74	73	7.4	68
PRG			5.21[d]	450[c]	--	41,000[c]	--	150[c]	--	100,000[c]	2,130[d]	--	--	--	--	--	--	--	--
SSL (most restrictive)			--	--	--	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--
TTLC[1] (mg/kg)			500	100	--	2,500	--	1,000	--	5,000	--	--	--	--	--	--	--	--	--
Ecological Screening Benchmark			42[a]	4[a]	--	--	--	--	--	--	--	28,200[b]	--	--	--	--	--	--	--

Notes:

Bold indicates values above screening criteria

[1] = If a substance in a waste equals or exceeds the TTLC level, it is considered a hazardous toxic waste

[a] = Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al 1997)
[b] = Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. (Jones et al 1997)
[c] = Industrial PRG
[d] = Calculated recreational PRG using site-specific exposure scenario

-- = No standard
% = Percent
< = Not detected at the limit shown
ABP = Acid-base potential
AGP = Acid generation potential
ANP =Acid neutralization potential
EPA = U.S. Environmental Protection Agency
mg/kg = Milligrams per kilogram

NA = Not analyzed
NP $CaCO_3$ = Calcium carbonate
pCi/g = Picocuries per gram
PRG = Preliminary remediation goal
Ra = Radium
SSL = Soil screening level from EPA Soil Screening Guidelines for Radionuclides
Ton/kT = Tons $CaCO_3$ per 1,000 tons of sample
TTLC = Total Threshold Limit Concentration

TABLE 3-5
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (µR/hr)	Reading 1 meter Above Surface (µR/hr)	Cumulative Distance (feet)
SL-PIT	1	Mine Pit	6/24/1996	315	355	0
	2	Mine Pit	6/24/1996	525	500	10
	3	Mine Pit	6/24/1996	725	725	20
	4	Mine Pit	6/24/1996	525	550	30
	5	Mine Pit	6/24/1996	320	300	40
	6	Mine Pit	6/24/1996	280	240	50
	7	Mine Pit	6/24/1996	420	330	60
	8	Mine Pit	6/24/1996	260	370	70
	9	Mine Pit	6/24/1996	260	400	80
	10	Mine Pit	6/24/1996	225	270	90
	11	Mine Pit	6/24/1996	230	220	100
	12	Mine Pit	6/24/1996	250	205	110
	13	Mine Pit	6/24/1996	130	130	120
	14	Mine Pit	6/24/1996	130	125	130
	15	Mine Pit	6/24/1996	140	115	140
	16	Mine Pit	6/24/1996	120	120	150
	17	Mine Pit	6/24/1996	150	130	160
	18	Mine Pit	6/24/1996	140	140	170
	19	Mine Pit	6/24/1996	145	140	180
	20	Mine Pit	6/24/1996	100	105	190
SL-1	1	Waste Rock Pile No. 1	6/24/1996	95	115	0
	2	Waste Rock Pile No. 1	6/24/1996	200	165	10
	3	Waste Rock Pile No. 1	6/24/1996	120	100	20
	4	Waste Rock Pile No. 1	6/24/1996	75	85	30
	5	Waste Rock Pile No. 1	6/24/1996	100	115	40
	6	Waste Rock Pile No. 1	6/24/1996	135	145	50
	7	Waste Rock Pile No. 1	6/24/1996	200	190	60
	8	Waste Rock Pile No. 1	6/24/1996	150	145	70
	9	Waste Rock Pile No. 1	6/24/1996	100	105	80
	10	Waste Rock Pile No. 1	6/24/1996	100	100	90
	11	Waste Rock Pile No. 1	6/24/1996	95	100	100
	12	Waste Rock Pile No. 1	6/24/1996	130	120	110
	13	Waste Rock Pile No. 1	6/24/1996	130	130	120
	14	Waste Rock Pile No. 1	6/24/1996	110	105	130
	15	Waste Rock Pile No. 1	6/24/1996	110	110	140
	16	Waste Rock Pile No. 1	6/24/1996	110	115	150
	17	Waste Rock Pile No. 1	6/24/1996	155	135	160
	18	Waste Rock Pile No. 1	6/24/1996	85	95	170
	19	Waste Rock Pile No. 1	6/24/1996	75	85	180
	20	Waste Rock Pile No. 1	6/24/1996	65	80	190

TABLE 3-5
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
GAMMA SURVEY RESULTS
JUNIPER MINE
(Page 2 of 3)

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (µR/hr)	Reading 1 meter Above Surface (µR/hr)	Cumulative Distance (feet)
SL-2	1	Waste Rock Pile No. 2	6/24/1996	2000	1600	0
	2	Waste Rock Pile No. 2	6/24/1996	1200	1000	10
	3	Waste Rock Pile No. 2	6/24/1996	850	850	20
	4	Waste Rock Pile No. 2	6/24/1996	700	700	30
	5	Waste Rock Pile No. 2	6/24/1996	850	800	40
	6	Waste Rock Pile No. 2	6/24/1996	700	650	50
	7	Waste Rock Pile No. 2	6/24/1996	750	700	60
	8	Waste Rock Pile No. 2	6/24/1996	1250	950	70
	9	Waste Rock Pile No. 2	6/24/1996	900	850	80
	10	Waste Rock Pile No. 2	6/24/1996	750	650	90
	11	Waste Rock Pile No. 2	6/24/1996	900	550	100
	12	Waste Rock Pile No. 2	6/24/1996	350	400	110
	13	Waste Rock Pile No. 2	6/24/1996	310	380	120
	14	Waste Rock Pile No. 2	6/24/1996	430	415	130
	15	Waste Rock Pile No. 2	6/24/1996	410	380	140
	16	Waste Rock Pile No. 2	6/24/1996	365	315	150
	17	Waste Rock Pile No. 2	6/24/1996	250	265	160
	18	Waste Rock Pile No. 2	6/24/1996	255	230	170
	19	Waste Rock Pile No. 2	6/24/1996	135	145	180
	20	Waste Rock Pile No. 2	6/24/1996	155	150	190
SL-3	1	Waste Rock Pile No. 3	6/24/1996	15.5	16	0
	2	Waste Rock Pile No. 3	6/24/1996	15	15.5	10
	3	Waste Rock Pile No. 3	6/24/1996	15	15.5	20
	4	Waste Rock Pile No. 3	6/24/1996	15.5	15	30
	5	Waste Rock Pile No. 3	6/24/1996	15.5	14	40
	6	Waste Rock Pile No. 3	6/24/1996	14	14.5	50
	7	Waste Rock Pile No. 3	6/24/1996	14	15	60
	8	Waste Rock Pile No. 3	6/24/1996	15	15	70
	9	Waste Rock Pile No. 3	6/24/1996	16.5	17	80
	10	Waste Rock Pile No. 3	6/24/1996	18.5	17.5	90
	11	Waste Rock Pile No. 3	6/24/1996	17	16	100
	12	Waste Rock Pile No. 3	6/24/1996	17	17	110
	13	Waste Rock Pile No. 3	6/24/1996	18	16.5	120
	14	Waste Rock Pile No. 3	6/24/1996	17.5	16	130
	15	Waste Rock Pile No. 3	6/24/1996	18	18	140
	16	Waste Rock Pile No. 3	6/24/1996	16	16	150
	17	Waste Rock Pile No. 3	6/24/1996	17	17	160
	18	Waste Rock Pile No. 3	6/24/1996	16.5	17	170
	19	Waste Rock Pile No. 3	6/24/1996	16.5	17	180
	20	Waste Rock Pile No. 3	6/24/1996	15	15.5	190

TABLE 3-5
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION FOCUSED SITE INSPECTION
GAMMA SURVEY RESULTS
JUNIPER MINE
(Page 3 of 3)

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (µR/hr)	Reading 1 meter Above Surface (µR/hr)	Cumulative Distance (feet)
BACKGROUND	1	Northwest of mine along Forest Road 5N01	6/24/1996	11.5	10	0
	2	Northwest of mine along Forest Road 5N01	6/24/1996	11	11	10
	3	Northwest of mine along Forest Road 5N01	6/24/1996	10.5	11	20
	4	Northwest of mine along Forest Road 5N01	6/24/1996	11	11	30
	5	Northwest of mine along Forest Road 5N01	6/24/1996	11.5	10	40
	6	Northwest of mine along Forest Road 5N01	6/24/1996	10	12	50
	7	Northwest of mine along Forest Road 5N01	6/24/1996	10	9.5	60
	8	Northwest of mine along Forest Road 5N01	6/24/1996	10	9.5	70
	9	Northwest of mine along Forest Road 5N01	6/24/1996	9	10	80
	10	Northwest of mine along Forest Road 5N01	6/24/1996	10	10	90
	11	Northwest of mine along Forest Road 5N01	6/24/1996	10	11.5	100
	12	Northwest of mine along Forest Road 5N01	6/24/1996	10	11.5	110
	13	Northwest of mine along Forest Road 5N01	6/24/1996	11	11	120
	14	Northwest of mine along Forest Road 5N01	6/24/1996	10.5	11	130
	15	Northwest of mine along Forest Road 5N01	6/24/1996	11.5	11.5	140
	16	Northwest of mine along Forest Road 5N01	6/24/1996	11	11	150
	17	Northwest of mine along Forest Road 5N01	6/24/1996	10.5	10.5	160
	18	Northwest of mine along Forest Road 5N01	6/24/1996	11	10	170
	19	Northwest of mine along Forest Road 5N01	6/24/1996	10	11	180
	20	Northwest of mine along Forest Road 5N01	6/24/1996	11	11	190

Notes:

µR/hr = MicroRoentgens per hour
No. = Number

TABLE 3-6
TETRA TECH 2002 EE/CA INVESTIGATION
SURFACE WATER AND GROUNDWATER SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 1)

Sample Number	Sample Location	Sample Date	Total Arsenic (mg/L)	Total Cadmium (mg/L)	Total Calcium (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)	Total Magnesium (mg/L)	Total Potassium (mg/L)	Total Sodium (mg/L)	Total Thorium (µg/L)	Total Uranium (µg/L)	TDS (mg/L)	TSS (mg/L)	Chloride (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)	Orthophosphate as Phosphorus (mg/L)	Sulfate (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Carbonate as $CaCO_3$ (mg/L)	Hydroxide as $CaCO_3$ (mg/L)	Bicarbonate as $CaCO_3$ (mg/L)
T1-09/23/02-W-PP-G	Pit spring	9/23/2002	0.0065 J	<0.00018	20	<0.0069	<0.002	25	14	6.5	0.073 J	94	220	<4	0.4	<0.1	<0.2	<0.2	19	180	<50	<50	180
T1-09/23/02-W-PC-G	Pit Creek at road crossing	9/23/2002	0.0082 J	<0.00018	24	0.058 J	<0.002	24	13	6.7	0.087 J	170	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T1-09/23/02-W-WR2-G	Seep at base of Waste Rock Pile No. 2, adjacent to Pit Creek	9/23/2002	0.0057 J	<0.00018	NA	1.6	<0.002	NA	NA	NA	0.29 J	160	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T1-09/23/02-W-M-G	Creek at head of meadow	9/23/2002	<0.0028	<0.00018	NA	0.033 J	<0.002	NA	NA	NA	0.067 J	55	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ambient Water Quality Criteria			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Maximum Contaminant Level[1]			--	--	--	--	--	--	--	--	--	--	500[c]	--	--	10[b]	--	--	250[c]	--	--	--	--

Notes:

Bold indicates values above screening criteria

--	= No standard or standard not applicable to unfiltered water
[1]	= Marshack. "*A Compilation of Water Quality Goals.*" August 2000.
[a]	= California Department of Health Services Primary MCL
[b]	= U.S. EPA Primary MCL
[c]	= California Department of Health Services Secondary MCL
[d]	= U.S. EPA Secondary MCL
J	= Below reporting limit, but at or above instrument detection limit
$CaCO_3$	= Calcium carbonate
mg/L	= Milligrams per Liter
µg/L	= Micrograms per Liter
NA	= Not analyzed
ND	= Not detected
No.	= Number
pCi/g	= Picocuries per gram
TDS	= Total dissolved solids
TSS	= Total suspended solids

TABLE 3-7
TETRA TECH 2002 EE/CA INVESTIGATION
SOIL SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 1)

Sample Number	Matrix	Sample Location	Sample Date	Lead (mg/kg)	Thorium (mg/kg)	Uranium (mg/kg)	Ra-226 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Pb-210 (pCi/g)	Arsenic (mg/L)	Cadmium (mg/L)	Lead (mg/L)	Thorium (µg/L)	Uranium (µg/L)
T1-09/22/02-S-WR2-G	Soil	Waste Rock Pile No. 2 Hot Spot	9/22/2002	24	9.8	**1,300**	**416**	**3.1**	**0.89**	**920**	2.02	**328**	**14.6**	**316**	**641**	NA	NA	NA	NA	NA
T1-09/23/02-S-WR-C	Soil	Composite of all Waste Rock Piles	9/23/2002	8.7	6.5	**230**	**88**	**2**	0.80	**107**	0.87	60.7	**3.22**	**67.4**	**79**	NA	NA	NA	NA	NA
T1-09/23/02-S-WR1-C	Soil Leachate	Waste Rock Pile No. 1 Composite	9/23/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.03	<0.00018	0.0056	8.70	120
T1-09/23/02-S-WR2-C	Soil Leachate	Waste Rock Pile No. 2 Composite	9/23/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0028	0.00071 J	<0.002	0.27 J	26
T1-09/23/02-S-WR3-C	Soil Leachate	Waste Rock Pile No. 3 Composite	9/23/2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.00027 J	0.0096	10	8.2
PRG				150[c]	--	1,064[d]	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Federal Ambient Water Quality Criteria				--	--	--	--	--	--	--	--	--	--	--	--	0.000018	0.0022	0.0025	--	--
Maximum Contaminant Level[1]				--	--	--	--	--	--	--	--	--	--	--	--	0.01[a,b]	0.005[a,b]	0.015[a,b]	--	30[b]
SSL (most restrictive)				--	--	--	0.2	0.64	0.81	60	52	76	3.1	15	5.3	--	--	--	--	--
TTLC[2] (mg/kg)				1,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
STLC (mg/L)				--	--	--	--	--	--	--	--	--	--	--	--	5	1	5	--	--
Ecological Screening Benchmark				--	--	5	50	40	--	--	2,000	5,000	3,000	2,000	--	--	--	--	--	--

Notes:

Bold indicates values above screening criteria

1 = Marshack. "*A Compilation of Water Quality Goals.*" August 2000.
2 = If a substance in a waste equals or exceeds the TTLC level, it is considered a hazardous toxic waste

a = California Department of Health Services Primary MCL
b = U.S. EPA Primary MCL
c = Industrial PRG
d = Calculated recreational PRG using site-specific expsoure scenario

J = Below reporting limit, but at or above instrument detection limit

$CaCO_3$ = Calcium carbonate
µg/L = Micrograms per Liter
mg/kg = Milligrams per kilogram
mg/L = Milligrams per Liter
NA = Not analyzed
ND = Not detected
No. = Number
Pb = Lead

pCi/g = Picocuries per gram
PRG = Preliminary remediation goal
Ra = Radium
SSL = Soil screening level from EPA Soil Screening Guidelines for Radionuclides
STLC = Soluable Threshold Limit Concentration
Th = Thorium
TTLC = Total Threshold Limit Concentration
U = Uranium

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-PIT	PIT-1	Mine Pit	9/22/2002	275	175	0
	PIT-2	Mine Pit	9/22/2002	6,500	5,500	10
	PIT-3	Mine Pit	9/22/2002	4,500	4,500	20
	PIT-4	Mine Pit	9/22/2002	5,500	3,500	30
	PIT-5	Mine Pit	9/22/2002	350	250	40
	PIT-6	Mine Pit	9/22/2002	90	90	50
	PIT-7	Mine Pit	9/22/2002	65	70	60
	PIT-8	Mine Pit	9/22/2002	155	140	70
	PIT-9	Mine Pit	9/22/2002	145	130	80
	PIT-10	Mine Pit	9/22/2002	85	95	90
	PIT-11	Mine Pit	9/22/2002	70	75	100
	PIT-12	Mine Pit	9/22/2002	70	75	110
	PIT-13	Mine Pit	9/22/2002	80	75	120
	PIT-14	Mine Pit	9/22/2002	75	70	130
	PIT-15	Mine Pit	9/22/2002	55	55	140
	PIT-16	Mine Pit	9/22/2002	50	45	150
	PIT-17	Mine Pit	9/22/2002	40	40	160
	PIT-18	Mine Pit	9/22/2002	40	40	170
	PIT-19	Mine Pit	9/22/2002	30	30	180
	PIT-20	Mine Pit	9/22/2002	45	45	190
	PIT-21	Mine Pit	9/22/2002	45	40	200
SL-WR2	WR2-1	Waste Rock Pile No. 2	9/21/2002	8,000	6,000	0
	WR2-2	Waste Rock Pile No. 2	9/21/2002	10,750	9,500	10
	WR2-3	Waste Rock Pile No. 2	9/21/2002	10,000	9,500	20
	WR2-4	Waste Rock Pile No. 2	9/21/2002	8,000	8,000	30
	WR2-5	Waste Rock Pile No. 2	9/21/2002	11,000	8,500	40
	WR2-6	Waste Rock Pile No. 2	9/21/2002	11,000	8,000	50
	WR2-7	Waste Rock Pile No. 2	9/21/2002	11,500	8,000	60

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-WR2	WR2-8	Waste Rock Pile No. 2	9/21/2002	8,500	8,000	70
	WR2-9	Waste Rock Pile No. 2	9/21/2002	11,000	8,000	80
	WR2-10	Waste Rock Pile No. 2	9/21/2002	8,000	6,000	90
	WR2-11	Waste Rock Pile No. 2	9/21/2002	6,000	5,000	100
	WR2-12	Waste Rock Pile No. 2	9/21/2002	5,500	4,500	110
	WR2-13	Waste Rock Pile No. 2	9/21/2002	6,000	4,500	120
	WR2-14	Waste Rock Pile No. 2	9/21/2002	5,500	4,500	130
	WR2-15	Waste Rock Pile No. 2	9/21/2002	4,500	3,500	140
	WR2-16	Waste Rock Pile No. 2	9/21/2002	2,800	2,750	150
	WR2-17	Waste Rock Pile No. 2	9/21/2002	325	250	160
	WR2-18	Waste Rock Pile No. 2	9/21/2002	175	175	170
	WR2-19	Waste Rock Pile No. 2	9/21/2002	200	150	180
	WR2-20	Waste Rock Pile No. 2	9/21/2002	125	125	190
	WR2-21	Waste Rock Pile No. 2	9/21/2002	150	125	200
SL-PC1	PC1-1	Pit Creek at road crossing	9/22/2002	32	32	0
	PC1-2	Pit Creek at road crossing	9/22/2002	50	45	3
	PC1-3	Pit Creek at road crossing	9/22/2002	52	45	6
	PC1-4	Pit Creek at road crossing	9/22/2002	55	45	9
	PC1-5	Pit Creek at road crossing	9/22/2002	55	35	12
	PC1-6	Pit Creek at road crossing	9/22/2002	75	60	15
	PC1-7	Pit Creek at road crossing	9/22/2002	60	55	18
	PC1-8	Pit Creek at road crossing	9/22/2002	60	50	21
SL-PC2	PC2-1	Pit Creek above main creek	9/22/2002	15	13	0
	PC2-2	Pit Creek above main creek	9/22/2002	20	13	3
	PC2-3	Pit Creek above main creek	9/22/2002	20	18	6
	PC2-4	Pit Creek above main creek	9/22/2002	25	25	9

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-PC2	PC2-5	Pit Creek above main creek	9/22/2002	45	40	12
	PC2-6	Pit Creek above main creek	9/22/2002	38	28	15
	PC2-7	Pit Creek above main creek	9/22/2002	30	23	18
	PC2-8	Pit Creek above main creek	9/22/2002	23	20	21
SL-APC	APC-1	Main creek above Pit Creek	9/22/2002	18	15	0
	APC-2	Main creek above Pit Creek	9/22/2002	18	15	3
	APC-3	Main creek above Pit Creek (in Creek)	9/22/2002	23	30	6
	APC-4	Main creek above Pit Creek	9/22/2002	20	20	9
	APC-5	Main creek above Pit Creek	9/22/2002	18	18	12
	APC-6	Main creek above Pit Creek	9/22/2002	18	15	15
	APC-7	Main creek above Pit Creek	9/22/2002	18	18	18
	APC-8	Main creek above Pit Creek	9/22/2002	23	20	21
	APC-9	Main creek above Pit Creek	9/22/2002	25	20	24
	APC-10	Main creek above Pit Creek	9/22/2002	25	23	27
SL-UC1	UC1-1	Main creek below Pit Creek	9/22/2002	38	32	0
	UC1-2	Main creek below Pit Creek	9/22/2002	50	40	3
	UC1-3	Main creek below Pit Creek	9/22/2002	50	40	6
	UC1-4	Main creek below Pit Creek	9/22/2002	58	40	9
	UC1-5	Main creek below Pit Creek	9/22/2002	50	38	12
	UC1-6	Main creek below Pit Creek	9/22/2002	48	38	15
	UC1-7	Main creek below Pit Creek	9/22/2002	48	38	18
	UC1-8	Main creek below Pit Creek (in creek)	9/22/2002	63	40	21
	UC1-9	Main creek below Pit Creek	9/22/2002	55	38	24
	UC1-10	Main creek below Pit Creek	9/22/2002	35	30	27
SL-UC2	UC2-1	Main creek near canyon outlet	9/22/2002	18	15	0
	UC2-2	Main creek near canyon outlet	9/22/2002	18	15	3
	UC2-3	Main creek near canyon outlet	9/22/2002	30	23	6
	UC2-4	Main creek near canyon outlet	9/22/2002	30	25	9

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-UC2	UC2-5	Main creek near canyon outlet	9/22/2002	30	25	12
	UC2-6	Main creek near canyon outlet	9/22/2002	28	23	15
	UC2-7	Main creek near canyon outlet	9/22/2002	25	23	18
	UC2-8	Main creek near canyon outlet	9/22/2002	23	20	21
	UC2-9	Main creek near canyon outlet	9/22/2002	28	23	24
	UC2-10	Main creek near canyon outlet	9/22/2002	25	20	27
SL-M1	M1-1	Main creek at head of meadow	9/22/2002	25	20	0
	M1-2	Main creek at head of meadow	9/22/2002	25	20	3
	M1-3	Main creek at head of meadow	9/22/2002	25	20	6
	M1-4	Main creek at head of meadow	9/22/2002	25	20	9
	M1-5	Main creek at head of meadow	9/22/2002	23	20	12
	M1-6	Main creek at head of meadow	9/22/2002	20	30	15
	M1-7	Main creek at head of meadow (in creek)	9/22/2002	23	23	18
	M1-8	Main creek at head of meadow	9/22/2002	25	20	21
	M1-9	Main creek at head of meadow	9/22/2002	28	23	24
	M1-10	Main creek at head of meadow	9/22/2002	23	20	27
	M1-11	Main creek at head of meadow	9/22/2002	23	20	30
SL-M2	M2-1	Main creek in upper meadow	9/22/2002	85	70	0
	M2-2	Main creek in upper meadow	9/22/2002	75	65	3
	M2-3	Main creek in upper meadow	9/22/2002	70	65	6
	M2-4	Main creek in upper meadow	9/22/2002	60	60	9
	M2-5	Main creek in upper meadow	9/22/2002	75	60	12
	M2-6	Main creek in upper meadow (in creek)	9/22/2002	95	70	15
	M2-7	Main creek in upper meadow	9/22/2002	100	75	18
	M2-8	Main creek in upper meadow	9/22/2002	100	75	21
	M2-9	Main creek in upper meadow	9/22/2002	80	70	24
	M2-10	Main creek in upper meadow	9/22/2002	90	75	27

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-M3	M3-1	Main creek in middle meadow	9/22/2002	15	13	0
	M3-2	Main creek in middle meadow	9/22/2002	13	13	3
	M3-3	Main creek in middle meadow	9/22/2002	15	15	6
	M3-4	Main creek in middle meadow (in creek)	9/22/2002	20	18	9
	M3-5	Main creek in middle meadow (in creek)	9/22/2002	25	20	12
	M3-6	Main creek in middle meadow	9/22/2002	25	18	15
	M3-7	Main creek in middle meadow	9/22/2002	23	20	18
	M3-8	Main creek in middle meadow	9/22/2002	20	17	21
	M3-9	Main creek in middle meadow	9/22/2002	19	17	24
	M3-10	Main creek in middle meadow	9/22/2002	19	16	27
	M3-11	Main creek in middle meadow	9/22/2002	19	16	30
SL-LC1	LC1-1	Main creek in lower meadow	9/22/2002	19	17	0
	LC1-2	Main creek in lower meadow	9/22/2002	19	17	3
	LC1-3	Main creek in lower meadow	9/22/2002	19	19	6
	LC1-4	Main creek in lower meadow (in creek)	9/22/2002	19	18	9
	LC1-5	Main creek in lower meadow	9/22/2002	35	22	12
	LC1-6	Main creek in lower meadow	9/22/2002	23	20	15
	LC1-7	Main creek in lower meadow	9/22/2002	30	20	18
	LC1-8	Main creek in lower meadow	9/22/2002	25	20	21
	LC1-9	Main creek in lower meadow	9/22/2002	20	20	24
	LC1-10	Main creek in lower meadow	9/22/2002	20	18	27
	LC1-11	Main creek in lower meadow	9/22/2002	18	15	30
SL-LC2	LC2-1	Main creek at bottom of meadow	9/22/2002	25	18	0
	LC2-2	Main creek at bottom of meadow	9/22/2002	25	18	3
	LC2-3	Main creek at bottom of meadow	9/22/2002	25	18	6
	LC2-4	Main creek at bottom of meadow (in creek)	9/22/2002	15	15	9
	LC2-5	Main creek at bottom of meadow (in creek)	9/22/2002	15	15	12
	LC2-6	Main creek at bottom of meadow	9/22/2002	25	20	15

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-LC2	LC2-7	Main creek at bottom of meadow	9/22/2002	25	20	18
	LC2-8	Main creek at bottom of meadow	9/22/2002	20	15	21
	LC2-9	Main creek at bottom of meadow	9/22/2002	15	15	24
	LC2-10	Main creek at bottom of meadow	9/22/2002	15	13	27
	LC2-11	Main creek at bottom of meadow	9/22/2002	15	15	30
SL-UB	UB-1	Soil background above Waste Rock Pile No. 3	9/21/2002	12	10	0
	UB-2	Soil background above Waste Rock Pile No. 3	9/21/2002	10	9	10
	UB-3	Soil background above Waste Rock Pile No. 3	9/21/2002	13	9	20
	UB-4	Soil background above Waste Rock Pile No. 3	9/21/2002	11	11	30
	UB-5	Soil background above Waste Rock Pile No. 3	9/21/2002	11	10	40
	UB-6	Soil background above Waste Rock Pile No. 3	9/21/2002	11	9	50
	UB-7	Soil background above Waste Rock Pile No. 3	9/21/2002	11	11	60
	UB-8	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	70
	UB-9	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	80
	UB-10	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	90
	UB-11	Soil background above Waste Rock Pile No. 3	9/21/2002	13	11	100
	UB-12	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	110
	UB-13	Soil background above Waste Rock Pile No. 3	9/21/2002	13	11	120
	UB-14	Soil background above Waste Rock Pile No. 3	9/21/2002	11	11	130
	UB-15	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	140
	UB-16	Soil background above Waste Rock Pile No. 3	9/21/2002	11	10	150
	UB-17	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	160
	UB-18	Soil background above Waste Rock Pile No. 3	9/21/2002	12	11	170
	UB-19	Soil background above Waste Rock Pile No. 3	9/21/2002	13	11	180
	UB-20	Soil background above Waste Rock Pile No. 3	9/21/2002	13	12	190
	UB-21	Soil background above Waste Rock Pile No. 3	9/21/2002	13	11	200

TABLE 3-8
TETRA TECH 2002 EE/CA INVESTIGATION
GAMMA SURVEY RESULTS
JUNIPER MINE

Survey Line	Survey Point	Survey Location	Survey Date	Surface Reading (uR/hr)	Reading 1 meter Above Surface (uR/hr)	Cumulative Distance (feet)
SL-BUC	BUC-1	Main creek background above Waste Rock Pile No. 3	9/22/2002	10	9	0
	BUC-2	Main creek background above Waste Rock Pile No. 3	9/22/2002	10	9	3
	BUC-3	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	11	6
	BUC-4	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	11	9
	BUC-5	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	10	12
	BUC-6	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	11	15
	BUC-7	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	10	18
	BUC-8	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	10	21
	BUC-9	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	10	24
	BUC-10	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	10	27
	BUC-11	Main creek background above Waste Rock Pile No. 3	9/22/2002	11	10	30
SL-SMB	SMB-1	Sardine Meadow background	9/22/2002	37	36	0
	SMB-2	Sardine Meadow background	9/22/2002	37	36	3
	SMB-3	Sardine Meadow background	9/22/2002	35	33	6
	SMB-4	Sardine Meadow background	9/22/2002	35	30	9
	SMB-5	Sardine Meadow background	9/22/2002	35	33	12
	SMB-6	Sardine Meadow background	9/22/2002	37	33	15
	SMB-7	Sardine Meadow background	9/22/2002	37	35	18
	SMB-8	Sardine Meadow background	9/22/2002	37	35	21
	SMB-9	Sardine Meadow background	9/22/2002	35	30	24
	SMB-10	Sardine Meadow background	9/22/2002	35	35	27

Notes:

μR/hr = MicroRoentgens per hour
No. = Number

All creek transects included the creek and both banks to account for overbank sediment deposits.

TABLE 3-9
TETRA TECH 2004 EE/CA INVESTIGATION
SURFACE WATER AND GROUNDWATER SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 4)

Sample Number	Sample Location	Sample Date	Dissolved Aluminum (µg/L)	Dissolved Antimony (µg/L)	Dissolved Arsenic (µg/L)	Dissolved Barium (µg/L)	Dissolved Beryllium (µg/L)	Dissolved Cadmium (µg/L)	Dissolved Calcium (µg/L)	Dissolved Chromium (µg/L)	Dissolved Cobalt (µg/L)	Dissolved Copper (µg/L)	Dissolved Iron (µg/L)	Dissolved Lead (µg/L)	Dissolved Magnesium (µg/L)
07/07/04-LC2-W-G-F	Red Rock Creek Lower Meadow	7/7/2004	<7.7	<3.2	<3.1	38 J	<0.05	<0.22	8,500	<2.9	<0.56	1.2 J	67 J	<1.1	5,000
07/07/04-M2-W-G-F	Red Rock Creek Middle Meadow	7/7/2004	<7.7	<3.2	<3.1	42 J	<0.03	<0.19	7,600	<2.9	<0.56	<0.74	<38	<1.1	4,600
07/07/04-UC2-W-G-F	End of Red Rock Creek Canyon	7/7/2004	<7.7	<3.2	<3.1	42 J	<0.029	<0.14	7,400	<2.9	<0.56	0.8	<31	<1.1	4,900
07/07/04-UC1-W-G-F	Confluence of Pit and Red Rock Creeks	7/7/2004	<7.7	<3.2	<3.1	86 J	<0.03	<0.14	17,000	<2.9	<0.56	0.8	<22	<1.1	15,000
07/07/04-PC1-W-G-F	Pit Creek at Road Crossing	7/7/2004	<7.7	<3.2	**5 J**	89 J	<0.05	<0.22	24,000	<2.9	0.81 J	0.96	<29	<1.1	22,000
07/07/04-WR2-W-G-F	Seep Below Waste Rock Pile No.2	7/7/2004	<7.7	<3.2	**3.2 J**	90 J	<0.06	<0.2	55,000	<2.9	1.4 J	1.2	<54	<1.1	19,000
07/07/04-WR1-W-G-F	Spring North of Waste Rock Pile No.1	7/7/2004	<7.7	<3.2	<3.1	53 J	0.08 J	<0.14	18,000	<2.9	<0.56	0.57	<60	<1.1	9,400
07/07/04-BUC-W-G-F	Upper Red Rock Creek Tributary	7/7/2004	<11	<3.2	<3.1	32 J	<0.07	<0.14	4,400	<2.9	<0.56	0.56	<18	<1.1	2,800
07/07/04-BG-W-G-F	Background Spring in Sardine Meadow	7/7/2004	**140**	<3.2	<3.1	32 J	<0.07	<0.14	19,000	<2.9	<0.56	0.79	100	<1.1	10,000
07/07/04-PS-W-G-F	Pit Spring	7/7/2004	<7.7	<3.2	**5.5 J**	83 J	<0.07	<0.2	20,000	<2.9	<0.56	0.66	<18	<1.1	23,000
10/1/04-MW-1-W-F	Upgradient Monitoring Well (MW-1)	10/1/2004	**80,000**	3.4 J	**77**	490	**8.5**	<0.2	34,000	**120**	58	**180**	**61,000**	**64**	47,000
10/1/04-MW-2-W-F	Downgradient Monitoring Well (MW-2)	10/1/2004	38 J	<2.1	**2.9 J**	55 J	0.14 J	<0.2	130,000	25	<0.49	0.56 J	57 J	<1.1	72,000
Federal Ambient Water Quality Criteria			87	5.6	0.018	1,000	--	2.2	--	74	--	9	300	2.5	--
Maximum Contaminant Level[1]			200[c,d]	6[a,b]	10[b]	1,000[a]	4[a,b]	5[a]	--	50[a]	--	1,000[c,d]	300[c,d]	15[a,b]	--

TABLE 3-9
TETRA TECH 2004 EE/CA INVESTIGATION
SURFACE WATER AND GROUNDWATER SAMPLING RESULTS
JUNIPER MINE
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Sample Number	Sample Location	Sample Date	Dissolved Manganese (µg/L)	Dissolved Mercury (µg/L)	Dissolved Molybdenum (µg/L)	Dissolved Nickel (µg/L)	Dissolved Potassium (µg/L)	Dissolved Selenium (µg/L)	Dissolved Silver (µg/L)	Dissolved Sodium (µg/L)	Dissolved Thallium (µg/L)	Dissolved Vanadium (µg/L)	Dissolved Zinc (µg/L)	Dissolved Thorium (µg/L)	Dissolved Uranium (µg/L)
07/07/04-LC2-W-G-F	Red Rock Creek Lower Meadow	7/7/2004	27	<0.0031	3 J	<1.8	2,200	4.7 J	<0.51	2,900	<3.8	1.4 J	2.9 J	<0.081	6.9
07/07/04-M2-W-G-F	Red Rock Creek Middle Meadow	7/7/2004	**100**	<0.0031	<1.6	<1.8	2,500	<2.8	<0.51	2,600	<3.8	2.2 J	<1.4	<0.06	7.6
07/07/04-UC2-W-G-F	End of Red Rock Creek Canyon	7/7/2004	9.9 J	<0.0031	<1.6	<1.8	3,000	<2.8	<0.51	2,700	<3.9	2.1 J	<1.8	<0.06	11
07/07/04-UC1-W-G-F	Confluence of Pit and Red Rock Creeks	7/7/2004	24	<0.0031	3.7 J	<1.8	9,000	3.1 J	<0.51	4,800	<3.8	1.4 J	<0.94	<0.054	**77**
07/07/04-PC1-W-G-F	Pit Creek at Road Crossing	7/7/2004	42	<0.0031	5 J	<1.8	13,000	<2.8	<0.51	6,300	<3.8	1.5 J	<1.7	<0.05	**120**
07/07/04-WR2-W-G-F	Seep Below Waste Rock Pile No.2	7/7/2004	**160**	<0.0031	2.9 J	2.7	2,100	<2.8	<0.51	5,900	<4.6	1.1 J	<0.51	<0.048	**210**
07/07/04-WR1-W-G-F	Spring North of Waste Rock Pile No.1	7/7/2004	47	<0.0031	2.3 J	<1.8	2,500	**5.6**	<0.51	2,900	**5.7 J**	0.52 J	<1.2	<0.075	5.1
07/07/04-BUC-W-G-F	Upper Red Rock Creek Tributary	7/7/2004	0.97 J	<0.0031	<1.6	<1.8	1,600	<2.8	<0.51	1,900	<3.8	1.6 J	<0.47	<0.06	0.083 J
07/07/04-BG-W-G-F	Background Spring in Sardine Meadow	7/7/2004	2.4 J	<0.0031	<1.6	<1.8	2,500	<2.8	<0.51	4,800	<4.4	1.8 J	<0.99	<0.068	0.25
07/07/04-PS-W-G-F	Pit Spring	7/7/2004	0.85 J	<0.0031	4.8 J	<1.8	13,000	<2.8	0.61 J	6,200	<3.9	0.76 J	<0.62	<0.05	**81**
10/1/04-MW-1-W-F	Upgradient Monitoring Well (MW-1)	10/1/2004	**560**	0.16 J	72	**91**	41,000	<2.9	<0.51	71,000	<3.1	200	**1,000**	120	**87**
10/1/04-MW-2-W-F	Downgradient Monitoring Well (MW-2)	10/1/2004	**130**	<0.016	10	4.3 J	19,000	3.5 J	<0.51	63,000	<3.1	1.2 J	**300**	0.2 J	**66**
Federal Ambient Water Quality Criteria			100	0.77	--	52	--	5	3.4	--	1.7	--	120	--	--
Maximum Contaminant Level[1]			50[c,d]	2[a,b]	--	100[a]	--	50[a,b]	100[c,d]	--	2[a,b]	--	5,000[c,d]	--	30[b]

TABLE 3-9
TETRA TECH 2004 EE/CA INVESTIGATION
SURFACE WATER AND GROUNDWATER SAMPLING RESULTS
JUNIPER MINE
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Sample Number	Sample Location	Sample Date	Dissolved Ra-226 (pCi/L)	Dissolved Th-228 (pCi/L)	Dissolved Th-230 (pCi/L)	Dissolved Th-232 (pCi/L)	Dissolved U-234 (pCi/L)	Dissolved U-235 (pCi/L)	Dissolved U-238 (pCi/L)	Dissolved Pb-210 (pCi/L)	Dissolved Po-210 (pCi/L)
07/07/04-LC2-W-G-F	Red Rock Creek Lower Meadow	7/7/2004	0.49 +/- 0.28 J	<0 +/- 0.024	<-0.044 +/- 0.053	<0.013 +/- 0.023	3.02 +/- 0.6	0.139 +/- 0.094 J	2.45 +/- 0.51	<0.04 +/- 0.41	<0.04 +/- 0.11
07/07/04-M2-W-G-F	Red Rock Creek Middle Meadow	7/7/2004	<0.27 +/- 0.19	<0.014 +/- 0.046	<0.102 +/- 0.084	<0.012 +/- 0.025	3.24 +/- 0.63	0.128 +/- 0.086 J	3.07 +/- 0.60	<0.03 +/- 0.43	<0.07 +/- 0.10
07/07/04-UC2-W-G-F	End of Red Rock Creek Canyon	7/7/2004	0.57 +/- 0.27 J	<0.009 +/- 0.039	<-0.048 +/- 0.049	<0.001 +/- 0.021	4.14 +/- 0.77	0.22 +/- 0.11	3.52 +/- 0.67	<-0.02 +/- 0.45	<0.03 +/- 0.10
07/07/04-UC1-W-G-F	Confluence of Pit and Red Rock Creeks	7/7/2004	2.61 +/- 0.75	<0.050 +/- 0.069	<0.007 +/- 0.063	<0.017 +/- 0.023	**27.9 +/- 4.4**	1.29 +/- 0.33	**25.6 +/- 4.1**	<-0.06 +/- 0.39	<0.07 +/- 0.11
07/07/04-PC1-W-G-F	Pit Creek at Road Crossing	7/7/2004	4.3 +/- 1.1	<0.005 +/- 0.049	<-0.037 +/- 0.057	<0.026 +/- 0.032	**44.9 +/- 7.1**	2.42 +/- 0.53	**39.2 +/- 6.2**	<0.06 +/- 0.41	<0.03 +/- 0.12
07/07/04-WR2-W-G-F	Seep Below Waste Rock Pile No.2	7/7/2004	**10.6 +/- 2.7**	<0.009 +/- 0.047	<0.039 +/- 0.068	<-0.001 +/- 0.022	**64 +/- 10**	4.33 +/- 0.85	**67 +/- 11**	**1.32 +/- 0.54**	0.57 +/- 0.26
07/07/04-WR1-W-G-F	Spring North of Waste Rock Pile No.1	7/7/2004	0.52 +/- 0.25 J	<0.009 +/- 0.040	<-0.043 +/- 0.051	0.029 +/- 0.026 J	1.93 +/- 0.43	0.108 +/- 0.082 J	1.72 +/- 0.39	0.98 +/- 0.53 J	0.20 +/- 0.15 J
07/07/04-BUC-W-G-F	Upper Red Rock Creek Tributary	7/7/2004	<0.12 +/- 0.16	<0.061 +/- 0.057	<0.020 +/- 0.063	<0.007 +/- 0.022	0.23 +/- 0.11	<-0.007 +/- 0.049	<0.074 +/- 0.067	<-0.10 +/- 0.42	0.09 +/- 0.11 J
07/07/04-BG-W-G-F	Background Spring in Sardine Meadow	7/7/2004	<0.17 +/- 0.14	<0.032 +/- 0.029	<-0.036 +/- 0.052	<0.004 +/- 0.021	0.29 +/- 0.13	<0.015 +/- 0.056	0.136 +/- 0.090 J	<-0.19 +/- 0.41	<0.02 +/- 0.10
07/07/04-PS-W-G-F	Pit Spring	7/7/2004	**6.6 +/- 1.7**	<0.005 +/- 0.023	<-0.004 +/- 0.061	<-0.002 +/- 0.023	**29.1 +/- 4.6**	1.35 +/- 0.34	**25.8 +/- 4.1**	**36.4 +/- 8.8**	2.6 +/- 0.75
10/1/04-MW-1-W-F	Upgradient Monitoring Well (MW-1)	10/1/2004	**15.2 +/- 3.9**	0.23 +/- 0.13	1.63 +/- 0.36	0.34 +/- 0.12	**25.6 +/- 4.1**	1.13 +/- 0.26	**21.0 +/- 3.4**	**10.2 +/- 2.5**	0.44 +/- 0.23 J
10/1/04-MW-2-W-F	Downgradient Monitoring Well (MW-2)	10/1/2004	<0.10 +/- 0.28	<-0.003 +/- 0.060	<-0.016 +/- 0.061	<0.014 +/- 0.025	**22.7 +/- 3.6**	0.96 +/- 0.23	**20.5 +/- 3.3**	<0.21 +/- 0.27	<0.017 +/- 0.086
Maximum Contaminant Level[1]			5[b]	15	15	15	20	20	20	1	15
Ecological Screening Benchmark			160[e]	--	--	--	--	--	--	--	--

TABLE 3-9
TETRA TECH 2004 EE/CA INVESTIGATION
SURFACE WATER AND GROUNDWATER SAMPLING RESULTS
JUNIPER MINE

Sample Number	Sample Location	Sample Date	TDS (mg/L)	TSS (mg/L)	Chloride (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)	Orthophosphate as Phosphorus (mg/L)	Sulfate (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Carbonate as $CaCO_3$ (mg/L)	Hydroxide as $CaCO_3$ (mg/L)	Bicarbonate as $CaCO_3$ (mg/L)
07/07/04-PC1-W-G	Pit Creek at Road Crossing	7/7/2004	210	<20	0.34	<0.1	<0.2	<0.2	17	170	<10	<10	160
07/07/04-BUC-W-G	Upper Red Rock Creek	7/7/2004	58	<20	<0.2	<0.1	<0.2	0.53	<1	30	<5	<5	30
07/07/04-PS-W-G	Pit Spring	7/7/2004	200	<20	0.41	<0.1	<0.2	<0.2	15	170	<10	<10	170
10/1/04-MW-1-W	Upgradient Monitoring Well (MW-1)	10/1/2004	470	1,400	39	0.1 U	0.2 U	0.2 U	32	200	20 U	20 U	200
10/1/04-MW-2-W	Downgradient Monitoring Well (MW-2)	10/1/2004	**930**	6	52	0.2 U	0.4 U	0.4 U	**400**	260	20 U	20 U	260
Federal Ambient Water Quality Criteria			--	--	230	--	--	--	--	--	--	--	--
Maximum Contaminant Level[1]			500[c]	--	--	10[b]	--	--	250[c]	--	--	--	--

Notes:

Bold indicates values above screening criteria

--	= No standard or standard not applicable to unfiltered water
[1]	= Marshack. "*A Compilation of Water Quality Goals.*" August 2000.
[a]	= California Department of Health Services Primary MCL
[b]	= U.S. EPA Primary MCL
[c]	= California Department of Health Services Secondary MCL
[d]	= U.S. EPA Secondary MCL
[e]	= ORNL water criteria, Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at Oak Ridge National Laboratory (BJC 1998)
J	= Below reporting limit, but at or above instrument detection limit
$CaCO_3$	= Calcium carbonate
mg/L	= Milligrams per Liter
pCi/L	= Picocuries per liter
µg/L	= Micrograms per Liter
No.	= Number
TDS	= Total dissolved solids
TSS	= Total suspended solids

TABLE 3-10
TETRA TECH 2004 EE/CA INVESTIGATION
SOIL SAMPLING RESULTS
JUNIPER MINE

Sample Number	Matrix	Sample Location	Sample Date	Aluminum (mg/kg)	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)
06/30/04-WR3-1-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	5,800	<0.39	**9.5**	120	0.97	<0.043	7,500	16	20	35	29,000	6.5	6,000	750
06/30/04-WR3-2-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	7,000	<0.39	**8.7**	130	0.79	<0.042	6,800	15	19	31	26,000	7.2	4,200	930
06/30/04-WR3-3-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	5,600	<0.38	**7**	93	0.84	<0.021	12,000	22	16	31	21,000	6.9	8,300	630
PRG				100,000[e]	410[e]	3.04[f]	67,000[e]	1,900[e]	450[e]	--	450[e]	1,900[e]	41,000[e]	--	150[e]	--	19,000[e]
TTLC[2] (mg/kg)				--	500	500	10,000	75	100	--	2,500	8,000	2,500	--	1,000	--	--
Ecological Screening Benchmark						9.9[1]			4[1]								

Sample Number	Matrix	Sample Location	Sample Date	Mercury (mg/kg)	Molybdenum (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Thorium (mg/kg)	Uranium (mg/kg)
06/30/04-WR3-1-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	0.025 J	0.51 J	33	1,300	0.85 J	<0.077	350	1.9 J	34	72	7.9	5.4 J
06/30/04-WR3-2-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	0.021	1.1 J	27	1,200	<0.54	<0.075	310	1.5 J	34	64	7	5.6
06/30/04-WR3-3-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	0.018 J	1 J	28	1,300	<0.27	<0.074	310	0.84 J	28	50	7.6	4.9
PRG				310[e]	5,100[e]	20,000[e]	--	5,100[e]	5,100[e]	--	67[e]	1,000[e]	100,000[e]	--	1,064[f]
TTLC[2] (mg/kg)				20	3,500	2,000	--	100	500	--	700	2,400	5,000	--	--
Ecological Screening Benchmark															5[1]

Sample Number	Matrix	Sample Location	Sample Date	Ra-226 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Pb-210 (pCi/g)	Po-210 (pCi/g)
06/30/04-WR3-1-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	**2.76 +/- 0.73**	NA	**0.92 +/- 0.21**	2.83 +/- 0.54	0.86 +/- 0.20	2.05 +/- 0.36	0.153 +/- 0.056	2.31 +/- 0.40	2.21 +/- 0.59	1.8 +/- 0.42
06/30/04-WR3-2-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	**2.94 +/- 0.78**	NA	**0.98 +/- 0.23**	2.39 +/- 0.48	0.96 +/- 0.22	1.5 +/- 0.27	0.077 +/- 0.036	1.79 +/- 0.32	2.14 +/- 0.57	1.91 +/- 0.43
06/30/04-WR3-3-S-C	Soil	Waste Rock Pile No. 3 Composite	6/30/2004	**2.23 +/- 0.62**	NA	**0.95 +/- 0.21**	2.18 +/- 0.42	0.93 +/- 0.20	1.62 +/- 0.29	0.109 +/- 0.044	2.14 +/- 0.37	1.78 +/- 0.49	1.75 +/- 0.39
PRG				--	--	--	--	--	--	--	--	--	--
SSL (most restrictive)				0.2	0.64	0.81	60	52	76	3.1	15	5	280
Ecological Screening Benchmark				50[g]	40[g]	--	--	2,000[g]	5,000[g]	3,000[g]	2,000[g]	--	--

TABLE 3-10
TETRA TECH 2004 EE/CA INVESTIGATION
SOIL SAMPLING RESULTS
JUNIPER MINE
(Page 2 of 2)

Sample Number	Matrix	Sample Location	Sample Date	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Cadmium (mg/L)	Calcium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)
06/30/04-WR3-1-S-C	Soil Leachate	Waste Rock Pile No. 3 Composite	6/30/2004	0.44	<0.0032	0.0035	0.71	0.00064	0.00047	9.9	0.004	0.0058	0.015	0.59	0.01	7.1	0.2
Federal Ambient Water Quality Criteria				0.087	0.0056	0.000018	1	--	0.0022	--	0.074	--	0.009	0.3	0.0025	--	0.1
Maximum Contaminant Level[1]				1.0[a]/ 0.2[c,d]	0.006[a,b]	0.01[b]	1[a]	0.004[a,b]	0.005[a,b]	--	0.050[a]	--	1.3[a,b]/ 1[c,d]	0.3[c,d]	0.015[a,b]	--	0.050[c,d]
STLC (mg/L)				--	15	5	100	0.75	1	--	5	80	25	--	5	--	--

Sample Number	Matrix	Sample Location	Sample Date	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Potassium (mg/L)	Selenium (mg/L)	Silver (mg/L)	Sodium (mg/L)	Thallium (mg/L)	Vanadium (mg/L)	Zinc (mg/L)	Thorium (µg/L)	Uranium (µg/L)
06/30/04-WR3-1-S-C	Soil Leachate	Waste Rock Pile No. 3 Composite	6/30/2004	0.000033	<0.0016	0.0082	2.9	<0.0028	<0.00051	3	<0.0038	0.0031	0.46	0.13	3.3
Federal Ambient Water Quality Criteria				0.00077	--	0.052	--	0.005	0.0034	--	0.0017	--	0.12	--	--
Maximum Contaminant Level[1]				0.002[a,b]	--	0.1[a]	--	0.050[a,b]	0.1[c,d]	--	0.002[a,b]	--	5[c,d]	--	30[b]
STLC (mg/L)				0.2	350	20	--	1	5	--	7	24	250	--	--

Sample Number	Matrix	Sample Location	Sample Date	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-228 (pCi/L)	Th-230 (pCi/L)	Th-232 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)	Pb-210 (pCi/L)	Po-210 (pCi/L)
06/30/04-WR3-1-S-C	Soil Leachate	Waste Rock Pile No. 3 Composite	6/30/2004	<0.39 +/- 0.31	NA	<0.14 +/- 0.11	0.67 +/- 0.19	0.39 +/- 0.13	0.47 +/- 0.14	0.094 +/- 0.056 J	1.03 +/- 0.23	<0.35 +/- 0.33	<0.048 +/- 0.072
Federal Ambient Water Quality Criteria				--	--	--	--	--	--	--	--	--	--
Maximum Contaminant Level[1]				5[b]	--	15	15	15	20	20	20	1	15
STLC (mg/L)				--	--	--	--	--	--	--	--	--	--

Notes:

Bold indicates values above screening criteria

[1] = Marshack. "*A Compilation of Water Quality Goals.*" August 2000.
[2] = If a substance in a waste equals or exceeds the TTLC level, it is considered a hazardous toxic waste

[a] = California Department of Health Services Primary MCL
[b] = U.S. EPA Primary MCL
[c] = California Department of Health Services Secondary MCL
[d] = U.S. EPA Secondary MCL
[e] = Industrial PRG
[f] = Calculated recreational PRG using site-specific exposure scenario
[g] = RAD-BCG, A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE 2002)
[h] = Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at ORNL (BJC 1998)
[i] = Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al 1997)

J = Below reporting limit, but at or above instrument detection limit
$CaCO_3$ = Calcium carbonate
µg/L = Micrograms per Liter

mg/kg = Milligrams per kilogram
mg/L = Milligrams per Liter
NA = Not analyzed
No. = Number
Pb = Lead
Po = Polonium
pCi/g = Picocuries per gram
pCi/L = Picocuries per liter
PRG = Preliminary remediation goal
Ra = Radium
SSL = Soil screening level from EPA Soil Screening Guidelines for Radionuclides
STLC = Soluable Threshold Limit Concentration
Th = Thorium
TTLC = Total Threshold Limit Concentration
U = Uranium

TABLE 3-11
TETRA TECH 2004 EE/CA INVESTIGATION
SEDIMENT SAMPLING RESULTS
JUNIPER MINE
(Page 1 of 3)

Sample Number	Matrix	Sample Location	Sample Date	Aluminum (mg/kg)	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)
06/30/04-BUC-SED-C	Sediment	Upper Red Rock Creek Tributary	6/30/2004	21,000	0.66 J	4.6	180	0.88	<0.051	6,100	10	12	11	31,000	7.6	3,300	660
07/06/04-LC-SED-C	Sediment	Red Rock Creek Lower Meadow	7/6/2004	13,000	<0.44	**5.2**	120	0.71	<0.024	4,500	9.1	8.8	11	22,000	6.3	2,900	490
07/06/04-MM-SED-C	Sediment	Red Rock Creek Middle Meadow	7/6/2004	13,000	<0.46	**6.7**	150	0.92	<0.025	5,600	8.9	9.8	16	26,000	6.4	2,900	470
07/06/04-UM-SED-C	Sediment	Red Rock Creek Upper Meadow	7/6/2004	10,000	0.54 J	**6**	120	0.63 J	<0.022	5,600	8.1	8.9	9.3	19,000	5.8	3,100	610
07/06/04-UC-SED-C	Sediment	Red Rock Creek Upper Canyon	7/6/2004	9,500	1.2 J	**14**	150	0.83	0.057 J	9,600	11	17	18	26,000	7	5,300	710
PRG				100,000[e]	410[e]	5.21[e]	67,000[f]	1,900[e]	450[e]	--	450[e]	1,900[e]	41,000[e]	--	150[e]	--	19,000[e]
TTLC[2] (mg/kg)				--	500	500	10,000	75	100	--	2,500	8,000	2,500	--	1,000	--	--
Ecological Screening Benchmark						42[1]			4[1]								

Sample Number	Matrix	Sample Location	Sample Date	Mercury (mg/kg)	Molybdenum (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Thorium (mg/kg)	Uranium (mg/kg)
06/30/04-BUC-SED-C	Sediment	Upper Red Rock Creek Tributary	6/30/2004	0.013 J	0.6 J	4.9	1,200	1.1 J	<0.09	660	<0.94	81	55	3.7	1.4
07/06/04-LC-SED-C	Sediment	Red Rock Creek Lower Meadow	7/6/2004	0.1 J	<0.52	7.1	870	0.73	<0.085	300	<0.44	45	45	4.6	23
07/06/04-MM-SED-C	Sediment	Red Rock Creek Middle Meadow	7/6/2004	0.14 J	0.68 J	7.5	1,100	0.72 J	<0.09	340	0.6 J	58	56	5.5	18
07/06/04-UM-SED-C	Sediment	Red Rock Creek Upper Meadow	7/6/2004	0.079 J	<0.48	7.1	1,000	<0.29	<0.079	380	<0.41	41	40	6.8	22
07/06/04-UC-SED-C	Sediment	Red Rock Creek Upper Canyon	7/6/2004	0.38	1.4 J	18	1,200	0.37 J	<0.09	500	0.94 J	45	54	6.1	59
PRG				310[e]	5,100[e]	20,000[e]	--	5,100[e]	5,100[e]	--	67[e]	1,000[e]	100,000[e]	--	2130[f]
SSL				--	--	--	--	--	--	--	--	--	--	--	--
TTLC[2] (mg/kg)				20	3,500	2,000	--	100	500	--	700	2,400	5,000	--	--
Ecological Screening Benchmark															

TABLE 3-11
TETRA TECH 2004 EE/CA INVESTIGATION
SEDIMENT SAMPLING RESULTS
JUNIPER MINE
(Page 2 of 3)

Sample Number	Matrix	Sample Location	Sample Date	Ra-226 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Pb-210 (pCi/g)	Po-210 (pCi/g)
06/30/04-BUC-SED-C	Sediment	Upper Red Rock Creek Tributary	6/30/2004	**0.72 +/- 0.44**	NA	0.75 +/- 0.19	0.70 +/- 0.18	0.76 +/- 0.19	0.96 +/- 0.19	0.059 +/- 0.035	0.87 +/- 0.17	1.67 +/- 0.47	1.12 +/- 0.30
07/06/04-LC-SED-C	Sediment	Red Rock Creek Lower Meadow	7/6/2004	**5.3 +/- 1.2**	NA	**1.4 +/- 0.30**	6.1 +/- 1.1	1.23 +/- 0.27	7.7 +/- 1.2	0.54 +/- 0.12	7.7 +/- 1.2	5.7 +/- 1.4	5.0 +/- 0.90
07/06/04-MM-SED-C	Sediment	Red Rock Creek Middle Meadow	7/6/2004	**6.6 +/- 1.4**	NA	**0.94 +/- 0.21**	6.4 +/- 1.1	0.96 +/- 0.21	6.1 +/- 0.99	0.377 +/- 0.094	6.6 +/- 1.1	5.7 +/- 1.4	4.71 +/- 0.87
07/06/04-UM-SED-C	Sediment	Red Rock Creek Upper Meadow	7/6/2004	**7.3 +/- 1.5**	NA	**1.37 +/- 0.30**	8.3 +/- 1.5	1.31 +/- 0.28	8.7 +/- 1.4	0.402 +/- 0.098	8.5 +/- 1.4	6.4 +/- 1.6	5.01 +/- 0.94
07/06/04-UC-SED-C	Sediment	Red Rock Creek Upper Canyon	7/6/2004	**24.3 +/- 4.5**	NA	**0.84 +/- 0.21**	24.3 +/- 4.1	0.77 +/- 0.20	16.5 +/- 2.6	0.88 +/- 0.21	**16.9 +/- 2.7**	**20.7 +/- 5.0**	19.3 +/- 3.1
PRG				--	--	--	--	--	--	--	--	--	--
SSL (most restrictive)				0.2	0.64	0.81	120	100	150	3.1	15	11	550
Ecological Screening Benchmark				28,200[j]	--	--	--	2,000[g]	5,000[g]	3,000[g]	2,000[g]	--	--

Sample Number	Matrix	Sample Location	Sample Date	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Cadmium (mg/L)	Calcium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)
07/06/04-UC-SED-C	Sediment Leachate	Red Rock Creek Upper Canyon	7/6/2004	1.8 J	<0.0032	<0.0031	0.34	0.0001	0.00032	7.1	0.0034	0.0038	0.0049	2.5 J	0.0019	5.5	0.55
Federal Ambient Water Quality Criteria				0.087	0.0056	0.000018	1	--	0.0022	--	0.074	--	0.009	0.3	0.0025	--	--
Maximum Contaminant Level[1]				1[a]/ 0.2[c,d]	0.006[a,b]	0.01[a,b]	1[a]	0.004[a,b]	0.005[a,b]	--	0.050[a]	--	1[c,d]	0.3[c,d]	0.015[a,b]	--	0.050[c,d]
STLC (mg/L)				--	15	5	100	0.75	1	--	5	80	25	--	5	--	--

Sample Number	Matrix	Sample Location	Sample Date	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Potassium (mg/L)	Selenium (mg/L)	Silver (mg/L)	Sodium (mg/L)	Thallium (mg/L)	Vanadium (mg/L)	Zinc (mg/L)	Thorium (µg/L)	Uranium (µg/L)
07/06/04-UC-SED-C	Sediment Leachate	Red Rock Creek Upper Canyon	7/6/2004	0.000061	0.0048	0.0061	3.8 J	<0.0028	<0.00051	2.6	0.0038	<0.0079	0.17	0.41	8.7 J
Federal Ambient Water Quality Criteria				0.00077	--	0.052	--	0.005	0.0034	--	0.0017	--	0.12	--	--
Maximum Contaminant Level[1]				0.002[a,b]	--	0.1[a]	--	0.050[a,b]	0.1[c,d]	--	0.002[a,b]	--	5[c,d]	--	30[b]
STLC (mg/L)				0.2	350	20	--	1	5	--	7	24	250	--	--

TABLE 3-11
TETRA TECH 2004 EE/CA INVESTIGATION
SEDIMENT SAMPLING RESULTS
JUNIPER MINE

Sample Number	Matrix	Sample Location	Sample Date	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-228 (pCi/L)	Th-230 (pCi/L)	Th-232 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)	Pb-210 (pCi/L)	Po-210 (pCi/L)
07/06/04-UC-SED-C	Sediment Leachate	Red Rock Creek Upper Canyon	7/6/2004	1.62 +/- 0.65	NA	<0.047 +/- 0.045	3.19 +/- 0.61	0.075 +/- 0.047 J	4.54 +/- 0.78	0.151 +/- 0.072 J	4.52 +/- 0.78	**2.50 +/- 0.72**	5.0 +/- 1.0
Federal Ambient Water Quality Criteria					--	--	--	--	--	--	--	--	--
Maximum Contaminant Level[1]				5[b]	--	15	15	15	20	20	20	1	15
STLC (mg/L)				--	--	--	--	--	--	--	--	--	--

Notes:

Bold indicates values above screening criteria

[1] = Marshack. "*A Compilation of Water Quality Goals.*" August 2000.
[2] = If a substance in a waste equals or exceeds the TTLC level, it is considered a hazardous toxic waste

[a] = California Department of Health Services Primary MCL
[b] = U.S. EPA Primary MCL
[c] = California Department of Health Services Secondary MCL
[d] = U.S. EPA Secondary MCL
[e] = Industrial PRG
[f] = Calculated recreational PRG using site-specific exposure scenario
[g] = RAD-BCG, A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE 2002)
[h] = ORNL water criteria, Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at Oak Ridge National Laboratory (BJC 1998)
[i] = Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al 1997)
[j] = Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. (Jones et al 1997)

J = Below reporting limit, but at or above instrument detection limit
$CaCO_3$ = Calcium carbonate
µg/L = Micrograms per Liter
mg/kg = Milligrams per kilogram
mg/L = Milligrams per Liter
NA = Not analyzed
No. = Number
Pb = Lead
Po = Polonium
pCi/g = Picocuries per gram
pCi/L = Picocuries per liter
PRG = Preliminary remediation goal
Ra = Radium
SSL = Soil screening level from EPA Soil Screening Guidelines for Radionuclides
STLC = Soluable Threshold Limit Concentration
Th = Thorium
TTLC = Total Threshold Limit Concentration
U = Uranium

TABLE 3-12
TETRA TECH 2004 EE/CA INVESTIGATION
GAMMA SURVEY SUMMARY
JUNIPER MINE
(Page 1 of 2)

Survey Line	Description	Maximum Reading (uR/hr)	Average Reading (uR/hr)
WR2-AA	Transect AA on East Side of WR-2	315	252.5
WR2-A	Transect A on WR-2	345	211.7
WR2-B	Transect B on WR-2	430	239.6
WR2-C	Transect C on WR-2	600	268.8
WR2-D	Transect D on WR-2	950	362.3
WR2-E	Transect E on WR-2	725	400
WR2-F	Transect F on WR-2	1300	532.2
WR2-G	Transect G on WR-2	1425	537.5
WR2-H	Transect H on WR-2	650	279.2
WR2-I	Transect I on West Side of WR-2	200	141.3
OA-1	Outwash area below WR-2	90	34.58
OA-2	Outwash area below WR-2	65	27.33
OA-3	Outwash area below WR-2	40	23.06
OA-4	Outwash area below WR-2	42	23.35
OA-5	Outwash area below WR-2	70	32.24
OA-6	Outwash area below WR-2	22	17.79
OA-7	Outwash area below WR-1	65	29.97
OA-8	Outwash area below WR-1	65	27.19
OA-9	Outwash area below WR-1	65	24.09
OA-10	Outwash area below WR-1	55	21.09
PC-3	Pit Creek below road	60	41.85
PC-4	Pit Creek below road	49	38.92
PC-5	Pit Creek above Red Rock Creek	55	36.46
UC-3	Red Rock Creek below Confluence	49	38.69
UC-4	Red Rock Creek Canyon	42	33.67
UC-5	Red Rock Creek Canyon	50	39.92
UC-6	Red Rock Creek Canyon	48	39.78
UC-7	Red Rock Creek Canyon	44	34.33
UC-8	Red Rock Creek Canyon	45	31
UC-9	Red Rock Creek Canyon	40	34.89
UC-10	Red Rock Creek Canyon	37	29.23
UC-11	Red Rock Creek Canyon	38	28.5
UC-12	Red Rock Creek at bottom of Canyon	35	27.77
M-14	Upper Red Rock Meadow	27	23.12
M-13	Upper Red Rock Meadow	32	23.85
M-12	Upper Red Rock Meadow	31	22.32
M-11	Upper Red Rock Meadow	32	22.24
M-10	Middle of Red Rock Meadow	37	25.76
M-9	Middle of Red Rock Meadow	32	22.52
M-8	Middle of Red Rock Meadow	35	22.07
M-7	Middle of Red Rock Meadow	33	23.45
M-6	Middle of Red Rock Meadow	36	27.05
M-5	Middle of Red Rock Meadow	25	21.59
M-4	Middle of Red Rock Meadow	29	22.67
LC-5	Lower Red Rock Meadow	31	21.78

TABLE 3-12
TETRA TECH 2004 EE/CA INVESTIGATION
GAMMA SURVEY SUMMARY
JUNIPER MINE

Survey Line	Description	Maximum Reading (uR/hr)	Average Reading (uR/hr)
LC-5	Lower Red Rock Meadow	31	21.78
LC-4	Lower Red Rock Meadow	28	18.98
LC-3	Lower Red Rock Meadow	28	20.73
BM	Background in Red Rock Meadow	20	17.7
BUC	Background in Upper Red Rock Creek	18	17
UB-2	Background above mine	17	15.36

Notes:

Complete gamma survey results for the 2004 Investigation are presented in Appendix B.

μR/hr = MicroRoentgen per hour

4.0 IDENTIFICATION OF IMMINENT HUMAN HEALTH AND ECOLOGICAL HAZARDS AND THE NEED FOR A RESPONSE ACTION

This section identifies human health and ecological hazards and the need for a response action based on comparison of investigation data to human health and ecological benchmarks in Section 3, cumulative excess carcinogenic risk, and threats to water quality. Potential human health and ecological hazards to be evaluated include: exposure to gamma radiation from waste rock and sediment; exposure to metals and radionuclides in waste rock, surface water, groundwater, and sediment; and exposure to radon gas.

In order to determine whether a hazard poses an imminent threat to human health, excess carcinogenic risk was determined for each identified hazard. Identification of an imminent human health hazard was based on a cumulative excess carcinogenic risk greater than one person in ten thousand (1×10^{-4}) that could develop cancer over their lifetime based on the reasonable maximum exposure for an individual. Identification of imminent threats to ecological receptors was based on metal and radionuclide concentrations greater than two orders of magnitude above ecological benchmarks. Carcinogenic risk levels and threat to ecological receptors are described below for each identified hazard.

4.1 EXPOSURE TO GAMMA RADIATION

The high concentrations of Ra-226 present at Juniper Mine produce external gamma irradiation exposure. This conclusion is supported by the fact that gamma radiation surveys found a strong correlation between high gamma readings and high concentrations of Ra-226 in waste rock. Gamma radiation surveys detected external irradiation dose rates of approximately 11.5 mrem/hr at a hot area on top of Waste Rock Pile No.2 at Juniper Mine (Table 3-8). Gamma radiation levels in the hot area on top of Waste Rock Pile No.2 are over 600 times the site background dose rate (0.017 mrem/hr). Gamma radiation levels within the mine pit were detected at up to 6.5 mrem/hr (about 400 times the site background dose rate).

Gamma radiation levels at Waste Rock Pile No.1 and the outwash areas below Waste Rock Pile Nos.1 and 2 are up to 5 times (0.085 mrem/hr) the site background dose rate, while levels at Waste Rock Pile No.3 are similar to background (Tables 3-8 and 3-12). Sediment within Pit Creek exhibited gamma radiation levels up to 3.5 times (0.060 mrem/hr) the site background dose rate, while sediment within and deposited on the floodplain of the canyon reach of Red Rock Creek exhibited maximum gamma radiation levels up to 3 times (0.021 mrem/hr) background (Table 3-12). The distribution of gamma radiation at and downstream of Juniper Mine is presented in Figure 3-4.

For comparative purposes the U.S. Department of Energy (DOE) specifies that the general public should not be subjected to more than 100 mrem excess radiation dose each year, while the Nuclear Regulatory Commission (NRC) has set a plant decommissioning cleanup level of 25 mrem excess radiation dose each year for the general public. The Occupational Safety and Health Administration (OSHA) occupational radiation exposure limit is 5,000 mrem/yr or 1,250 mrem per quarter for the average worker in the nuclear industry. For CERCLA actions, USEPA has determined that the DOE and NRC levels are not protective of human health based on an evaluation of carcinogenic risk. EPA has determined that an excess radiation dose limit of 15 mrem each year is the highest dose that is still protective of the general public at CERCLA sites. By comparison, the USEPA specifies an excess radiation dose limit of 15 mrem per year for the general public at CERCLA sites (USEPA 1997). The 15 mrem/yr excess radiation dose limit is based on an incremental increase of one person in 3,333 (3×10^{-4}) that could develop cancer based on excess exposure to gamma radiation over their lifetime. Thus, a 1 to 2 hour exposure in areas on Waste Rock Pile No.2 or in the mine pit would exceed the USEPA annual dose limit for excess radiation exposure.

Several different types of recreational users currently access the site, including target shooters, hikers, campers, and off-road vehicle users. Although quantitative information regarding time spent by these users at the site is not available, it is reasonable to assume at least 1 to 2 hours a day might be spent at the site by target shooters and hikers, while campers and off-road vehicle users may spend one or two days at the site during each visit.

If a person recreated within the hot area at Waste Rock Pile No.2 every weekend for a six month period, then there is a one in three chance (2.8×10^{-1}) that a person could develop cancer due to excess exposure to gamma radiation over their lifetime. Exposure to gamma radiation in the mine pit would yield a one in six chance (1.6×10^{-1}) that a person could develop cancer over their lifetime. Exposure to gamma radiation at Waste Rock Pile No.1 or outwash areas below Waste Rock Pile Nos.1 and 2 would yield a one in 135 chance (7.39×10^{-3}) that a person could develop cancer over their lifetime, while exposure to sediment in Pit and Red Rock Creeks would yield an incremental increase in cancer risk of one in 225 (4.4×10^{-3}). The distribution of risk associated with gamma radiation at and downstream of Juniper Mine is presented in Figure 3-4. While carcinogenic risk associated with gamma radiation is above the 10^{-4} action level for justification of a response action, the permissible excess radiation dose limit of 15 mrem/year or 0.012 mrem/hr in addition to site background is also above the 10^{-4} action level (2.5×10^{-3}). Therefore, a response action is appropriate for source material (waste rock and low grade ore) and

secondary source areas (sediment accumulated within site drainages) that could continue to contribute radionuclides emitting gamma radiation to the environment.

4.2 EXPOSURE TO RADIONUCLIDES AND METALS FROM WASTE ROCK

Uranium and Ra-226 have been detected at concentrations up to 3,170 mg/kg and 1,750 pCi/g, respectively in waste rock at Juniper Mine. The concentrations of uranium are up to 3 times greater than the uranium recreational PRG and up to 635 times greater than the ecological benchmark at Waste Rock Pile No.2. Uranium is also above the ecological benchmark in the mine pit and Waste Rock Pile No.1. The uranium PRG value is based on non-carcinogenic toxicity of uranium. Ra-226 was detected above the recreational SSL at all locations, including background areas. The concentrations of Ra-226 are up to 8,750 greater than the Ra-226 recreational SSL and up to 35 times greater than the ecological benchmark at Waste Rock Pile No.2. Ra-226 is also of major concern in the mine pit and of limited concern at Waste Rock Pile No.1. The radionuclides U-234, U-235, and U-238 were detected at concentrations of 4 times, 5 times, and 21 times their respective recreational SSL values at Waste Rock Pile No.2. The radionuclides Th-230 and Pb-210 were also detected at concentrations of 15 times and 121 times their respective recreational SSL values at Waste Rock Pile No.2. These radionuclides are also of concern in the mine pit and at Waste Rock Pile No.1.

Recreational SSL values are based on an incremental increase of one person in one million (1×10^{-6}) that could develop cancer based on recreational exposure to a radionuclide over their lifetime. The maximum concentration of Ra-226 detected on Waste Rock Pile No.2 corresponds to an incremental increase of one person in 1,143 (8.75×10^{-4}) that could develop cancer over their lifetime. The maximum concentration of U-234, U-235, and U-238 detected on Waste Rock Pile No.2 corresponds to an incremental increase of one person in 231,707 (4.32×10^{-6}) for U-234, one person in 212,328 (4.71×10^{-6}) for U-235, and one person in 47,468 (2.11×10^{-5}) for U-238 that could develop cancer over their lifetime. The maximum concentration of Th-230 and Pb-210 detected on Waste Rock Pile No.2 corresponds to an incremental increase of one person in 65,217 (1.53×10^{-5}) for Th-230 and one person in 8,268 (1.2×10^{-4}) for Pb-210 that could develop cancer over their lifetime. Cumulative human health risk associated with radionuclides exceeding recreational SSLs at Waste Rock Pile No.2 is 8.85×10^{-3}, 1.92×10^{-3} in the mine pit, and 3.67×10^{-4} at Waste Rock Pile No.1. Cumulative human health risk associated with radionuclides at other sampling locations that do not exceed the 10^{-4} action level is presented in Table 4-1 and shown on Figure 4-1.

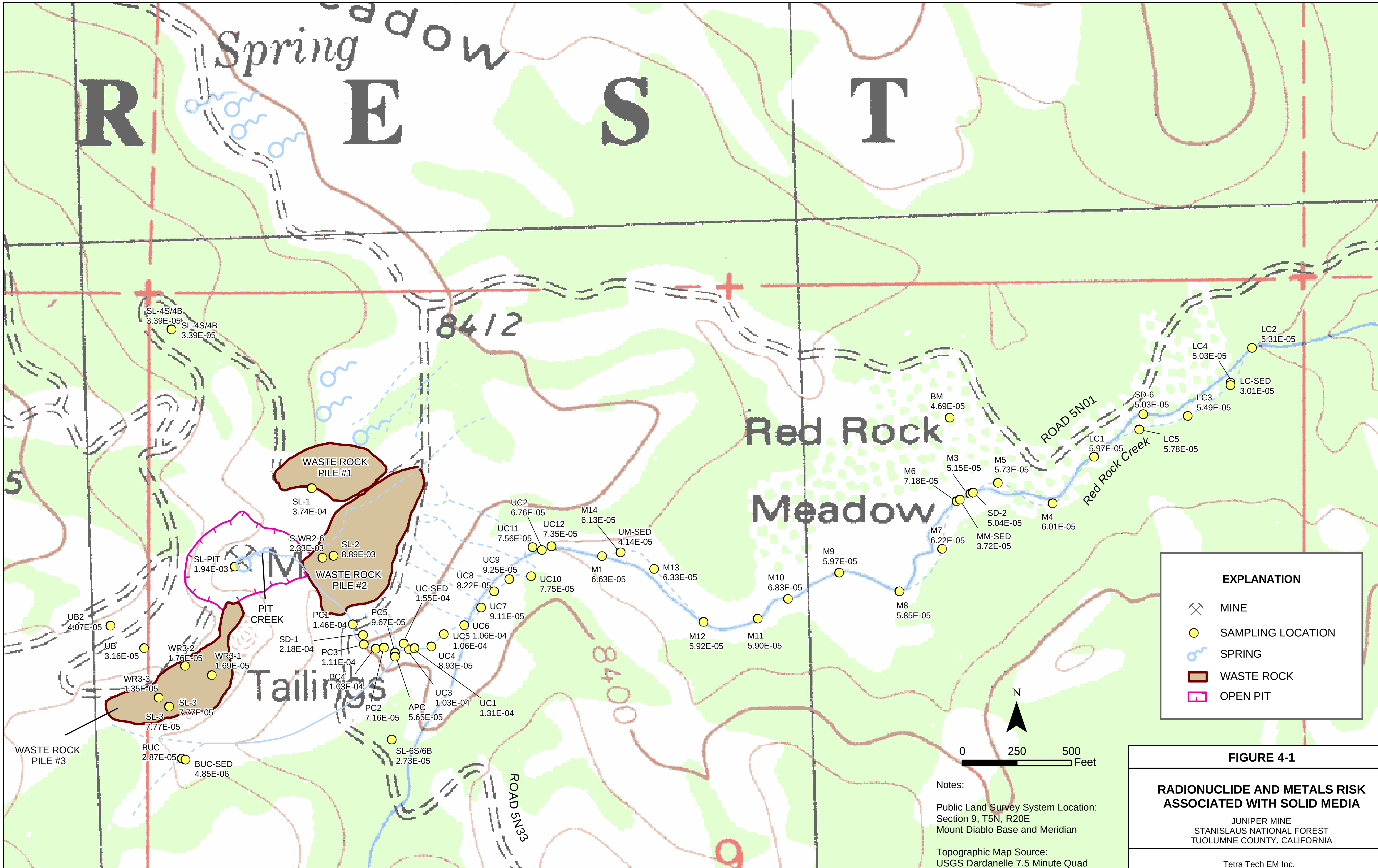


FIGURE 4-1

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SOLID MEDIA

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

Tetra Tech EM Inc.

2005-01-24 U:\juniper_mine\sed_basin\mxd\fig4-01_radionuclide_metals_solid.mxd TtEMI-SA K. Johnson

Arsenic has been detected at concentrations up to 116 mg/kg in waste rock at Juniper Mine. The concentrations of arsenic are up to 38 times greater than the arsenic recreational PRG and up to 12 times greater than the ecological benchmark. However, arsenic was not found to leach from waste rock at concentrations exceeding the STLC. Elevated arsenic levels were found in the mine pit and in Waste Rock Pile Nos. 2 and 3. Cadmium was detected at concentrations up to 5 times greater than the ecological benchmark, though at a concentration similar to background. The maximum concentration of arsenic detected at Waste Rock Pile No.2 corresponds to an incremental increase of one person in 26,207 (3.82×10^{-5}) that could develop cancer over their lifetime. Cumulative human health risk associated with arsenic at other sampling locations is presented in Table 4-1 and shown on Figure 4-1.

The human health and ecological risk screening suggests that a response action is appropriate due to exposure to arsenic, uranium, U-234, U-235, U-238, Th-230, Pb-210, and Ra-226 in the mine pit and Waste Rock Pile No. 1 and 2 after summation of risk associated with both metals and radionuclides. The concentrations of metals and radionuclides in waste rock at Waste Rock Pile No. 3 do not suggest the need for a response action.

4.3 EXPOSURE TO RADIONUCLIDES AND METALS IN SURFACE WATER AND GROUNDWATER

Surface Water

Uranium has been detected at concentrations up to 160 µg/L in Pit Creek at the Forest Road 5N33 crossing downstream of Juniper Mine. The concentrations of uranium are up to 5 times greater than the MCL. The radionuclides U-234 and U-238 were detected at concentrations of 2 times their respective MCLs in Pit Creek at the Forest Road 5N33 crossing. Uranium and the two radionuclides were also of concern in Red Rock Creek just below the confluence of Pit and Red Rock creeks. The concentrations of uranium and the two radionuclides decreased by about 36 percent just below the confluence of Pit and Red Rock creeks and up to 90 percent at the head of Red Rock Meadow, where uranium and radionuclide concentrations are below MCLs. None of the surface water samples exceeded the ecological benchmark for Ra-226 developed for Oak Ridge National Laboratory (ORNL) (Bechtel Jacobs Corporation [BJC] 1998).

MCL values are based on an incremental increase of one person in one million (1×10^{-6}) that could develop cancer based on recreational exposure to a radionuclide or metal over their lifetime. The maximum concentration of uranium detected in Pit Creek below the site corresponds to an incremental

increase of one person in 187,500 (5.33×10^{-6}). The maximum concentration of U-234 detected in Pit Creek corresponds to an incremental increase of one person in 445,434 (2.25×10^{-6}) that could develop cancer over their lifetime, while the maximum concentration of U-238 detected corresponds to an incremental increase of one person in 510,204 (1.96×10^{-6}) that could develop cancer over their lifetime. Cumulative human health risk associated with metals and radionuclides in Pit Creek sediment at Forest Road 5N33 crossing is 7.81×10^{-6} and 4.89×10^{-6} in Red Rock Creek just below the confluence with Pit Creek. Cumulative human health risk associated with radionuclides at other sampling locations is presented in Table 4-2 and shown on Figure 4-2. None of the surface water sampling locations demonstrated a cumulative risk that exceeded the 10^{-4} action level; however uranium is present at concentrations up to 5 times greater than the MCL.

While MCLs generally apply to finished water supplies, they may be considered relevant and appropriate for water that may be ingested untreated. For example, it is possible that hikers, campers, hunters or other recreational users of the Juniper Mine area may ingest stream water with little or no treatment, especially given the lack of any alternative designated drinking water supply in the area. Although this represents an intermittent, rather than continuous exposure scenario, given the elevated concentrations of uranium in the water an intermittent cumulative exposure may be sufficient to produce adverse chronic health effects.

<u>Groundwater</u>

Uranium was detected in groundwater at concentration of 210 µg/L in the seep below Waste Rock Pile No.2. The concentration of uranium was up to 7 times greater than the MCL. The radionuclides U-234 and U-238 were detected at concentrations of 3 times their respective MCLs, while Ra-226 was detected at concentrations up to 2 times the MCL. The radionuclide Pb-210, the end decay chain, was detected at concentrations up to 36 times the MCL. Uranium, U-234, U-238, Ra-226, and Pb-210 were also of concern in groundwater discharging from Pit Spring within the mine pit at Juniper Mine, though generally at concentrations approximately 50 percent less than the seep below Waste Rock Pile No.2. None of the seep samples exceeded the ecological benchmark for Ra-226 developed for ORNL (BJC 1998). It is important to note that the uranium and Ra-226 within groundwater and area springs is a natural occurrence associated with dissolution of uranium from the ore body.

Groundwater collected from monitoring wells installed up and down gradient of the mine also contained elevated concentrations of metals and radionuclides. Uranium was detected at a concentration of 87 µg/L in the up gradient well (MW-1) and 66 µg/L in the down gradient well (MW-2). The uranium

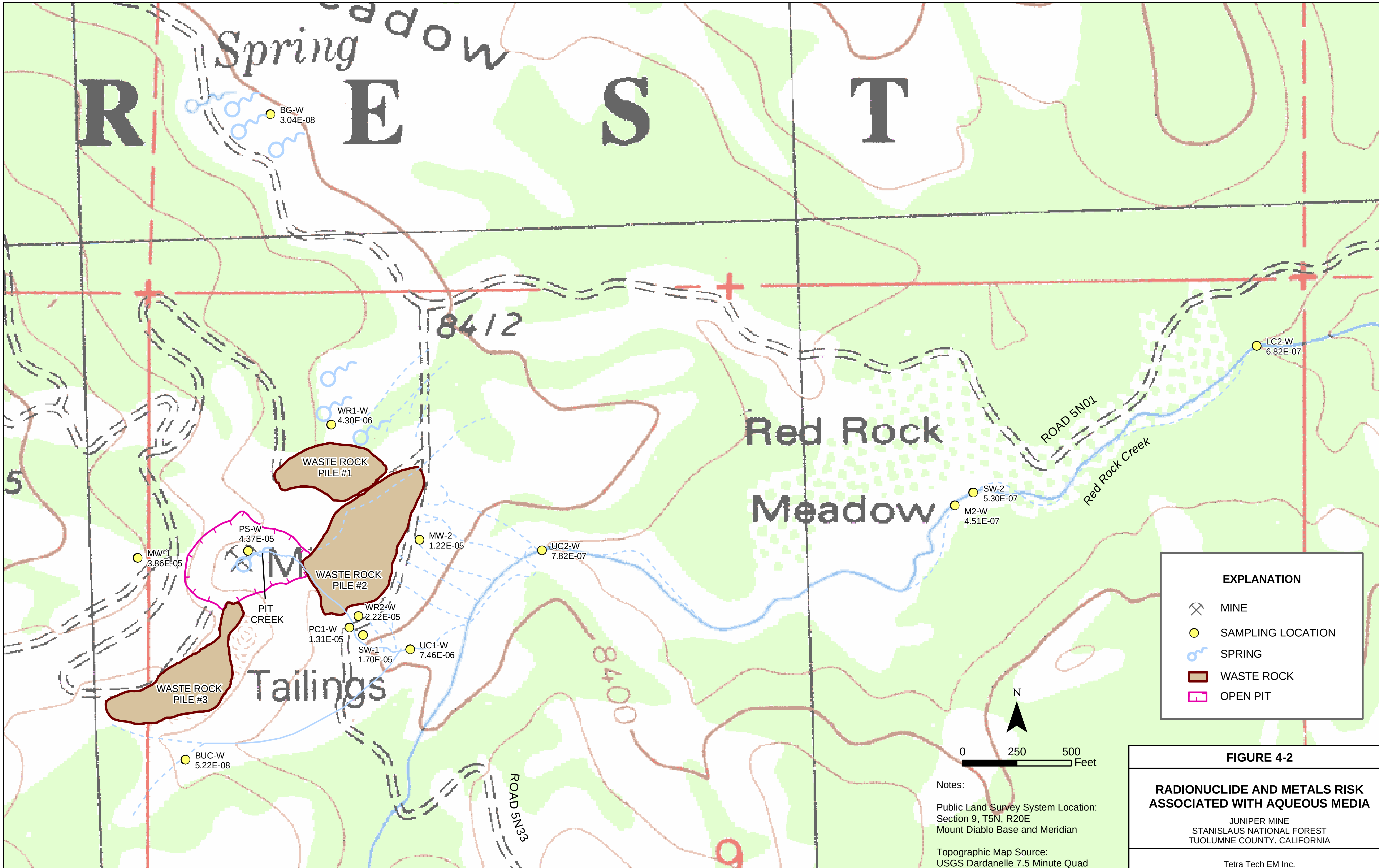


FIGURE 4-2

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH AQUEOUS MEDIA

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

Tetra Tech EM Inc.

concentration in up gradient groundwater was similar to that detected in the Pit Spring. The radionuclide Ra-226 was detected at concentrations up to 3 times the MCL, while Pb-210, the end decay chain, was detected at concentrations up to 10 times the MCL. None of the monitoring well samples exceeded the ecological benchmark for Ra-226 developed for ORNL (BJC 1998).

The up gradient well (MW-1), screened within the ore body, contained the highest levels of dissolved metals measured at the site. Arsenic was detected at concentrations 8 times the MCL, while beryllium, chromium, and lead were detected at concentrations ranging from 2 to 4 times their respective MCLs. Metals in groundwater down gradient of the mine (MW-2) did not exceed MCLs. The difference in dissolved metals concentrations is likely associated with the colloidal material that passed through the 0.45 micron filter in the groundwater sample collected from the up gradient monitoring well (MW-1).

The maximum concentration of uranium, U-234, and U-238 detected in groundwater was from the seep below Waste Rock Pile No.2. The maximum concentration of uranium detected corresponds to an incremental increase of one person in 142,857 (7.0×10^{-6}). The maximum concentration of U-234 detected corresponds to an incremental increase of one person in 312,500 (3.2×10^{-6}), while the maximum concentration of U-238 detected corresponds to an incremental increase of one person in 298,507 (3.35×10^{-6}) that could develop cancer over their lifetime. The maximum concentration of Ra-226 detected in groundwater (up gradient well [MW-1]) corresponds to an incremental increase of one person in 328,947 (3.04×10^{-6}), while the maximum concentration of Pb-210 detected in groundwater (Pit Spring) corresponds to an incremental increase of one person in 27,473 (3.64×10^{-5}) that could develop cancer over their lifetime. The maximum concentration of the metals arsenic, beryllium, chromium, and lead detected in groundwater (up gradient well [MW-1]) corresponds to an incremental increase of one person in 60,624 (1.65×10^{-5}) that could develop cancer over their lifetime.

The highest cumulative human health risk associated with metals and radionuclides in groundwater is 4.37×10^{-5} at Pit Spring within the mine pit, while cumulative risk in groundwater from the up gradient well (MW-1) is 3.86×10^{-5}. Cumulative human health risk associated with metals and radionuclides at other sampling locations is presented in Table 4-2 and shown on Figure 4-2. None of the groundwater sampling locations demonstrated a cumulative risk that exceeded the 10^{-4} action level; however uranium is present at concentrations up to 7 times greater than the MCL.

Uranium and radionuclides present in the groundwater emanating from the Pit Spring results from natural contact with the in-place ore body. Therefore, treatment of groundwater emanating from the pit spring is

not subject to remedial action under CERCLA 104(a)(3)(A) §9604. Because Pit Creek is primarily fed by the groundwater emanating from the pit spring, removal of uranium and radionuclides to their respective MCLs is not warranted. If an action is taken, uranium and radionuclides in Pit Creek, which discharges into Red Rock Creek, should be removed to levels equivalent to those found in the Pit Spring or up gradient groundwater if the effluent is discharged to groundwater. However, if the effluent is discharge to surface water, then the COCs must be treated to their respective MCLs.

4.4 EXPOSURE TO RADIONUCLIDES AND METALS IN SEDIMENT

The radionuclide Ra-226 has been detected at concentrations up to 43 pCi/g in Pit Creek and Red Rock Creek sediment downstream of Juniper Mine. The concentrations of Ra-226 are up to 215 times greater than the Ra-226 recreational SSL in Pit Creek sediment at the Forest Road 5N33 crossing. Ra-226 was detected above the recreational SSL at all locations, including background areas. The concentrations of Ra-226 in sediment decreased by about 44 percent just below the confluence of Pit and Red Rock creeks and up to 83 percent at the head of Red Rock Meadow. The radionuclides U-238, Th-228, and Pb-210 were detected at concentrations of 1 to 2 times their respective recreational SSL values within Pit Creek and Red Rock Creek just below the confluence with Pit Creek. None of the radionuclides exceeded ecological benchmarks.

Recreational SSL values are based on an incremental increase of one person in one million (1×10^{-6}) that could develop cancer based on recreational exposure to a radionuclide over their lifetime. The maximum concentration of Ra-226 detected in Pit Creek corresponds to an incremental increase of one person in 4,651 (2.15×10^{-4}) that could develop cancer over their lifetime. The maximum concentration of U-238, Th-228, and Pb-210 detected in Pit Creek and Red Rock Creek just below the confluence with Pit Creek corresponds to an incremental increase of one person in 887,573 (1.19×10^{-6}) for U-238, one person in 578,571 (1.73×10^{-6}) for Th-228, and one person in 531,401 (1.88×10^{-6}) for Pb-210 that could develop cancer over their lifetime. Cumulative human health risk associated with radionuclides exceeding recreational SSLs in Pit Creek sediment at Forest Road 5N33 crossing is 2.14×10^{-4} and 1.28×10^{-4} in Red Rock Creek just below the confluence with Pit Creek. Cumulative human health risk associated with radionuclides at other sampling locations that do not exceed the 10^{-4} action level is presented in Table 4-3 and shown on Figure 4-1.

Arsenic has been detected at concentrations up to 23 mg/kg in Pit Creek and Red Rock Creek sediment downstream of Juniper Mine. The concentrations of arsenic are up to 4 times greater than the arsenic

recreational PRG, did not exceed the ecological benchmark, and was not found to leach from sediment at concentrations exceeding the STLC. Elevated arsenic levels were found in the Pit Creek and Red Rock Creek just below the confluence with Pit Creek. Cadmium was detected at concentrations up to 10 times greater than the ecological benchmark, though at a concentration similar to background. The maximum concentration of arsenic detected in Pit Creek sediment corresponds to an incremental increase of one person in 226,522 (4.41×10^{-6}) that could develop cancer over their lifetime. Cumulative human health risk associated with arsenic at other sampling locations is presented in Table 4-3 and on Figure 4-1.

The human health and ecological risk screening suggests that a response action is appropriate due to exposure to Ra-226 in sediment within Pit Creek and Red Rock Creek just below the confluence with Pit Creek. The concentrations of metals and radionuclides in sediment in the meadow reach of Red Rock Creek do not suggest the need for a response action.

4.5 EXPOSURE TO RADON GAS

Ra-226 is the primary progenitor of radon gas. A modeling approach was used to assess the potential hazards associated with radon gas at Juniper Mine. Modeling was conducted using the RESRAD model (Yu et al. 2001) (see Appendix E for model output). RESRAD was used to conservatively predict the concentration of radon gas in ambient air based on the maximum concentration of Ra-226 detected at the mine (1,760 pCi/g on top of Waste Rock Pile No.2 [Table 3-3]). This modeling predicted an ambient concentration of radon gas of 36 pCi/L from Ra-226, far in excess of either typical outdoor background ambient air concentrations (0.4 pCi/L) or the EPA indoor air action level of 4 pCi/L (EPA 2003). It should be noted that this is a very conservative analysis since it assumed that the maximum detected Ra-226 concentration of 1,760 pCi/g exists over a very wide area (approximately 2 acres). Similar radon concentrations are expected within the mine pit due the presence of low grade ore and a confined environment.

Several different types of recreational users currently access the site, including target shooters, hikers, campers, and off-road vehicle users. Target shooters and hunters routinely use the mine pit high wall to stop lead shot and bullets. The hot area on top of Waste Rock Pile No.2 contains fire rings used by hunters and campers during overnight stays.

Inhalation of radon gas is associated with an increased risk of lung cancer. The indoor action level is based on an incremental increase of one person in 5,000 (2×10^{-4}) that could develop cancer based on

indoor exposure to a radon gas over their lifetime. There are no outdoor action levels for radon gas. The radon gas concentration of 36 pCi/L predicted by RESRAD therefore corresponds to an incremental increase of one person in 556 (1.8×10^{-3}) that could develop cancer over their lifetime, assuming an indoor exposure scenario in which the exposed individual lives in a home constructed on top of Waste Rock Pile No.2 or within the mine pit for their entire lifetime. Of course it is highly improbable that any recreational user would spend a similar amount of time at Juniper Mine, nonetheless, the highly conservative predicted concentration of radon gas at Juniper Mine may result in excess short-term radon gas exposure. Due to the overly conservative nature of the modeling and lack of radon gas data, an imminent threat to human health cannot be verified. Direct measurement of ambient radon gas should be conducted to confirm the predicted concentrations and more accurately assess excess cancer risk. Any action taken at the site should consider the contribution of radon gas in the overall remedy design.

4.6 BASIS FOR RESPONSE ACTION

Gamma radiation, radionuclides, and radon gas in and emitting from waste rock and sediment at the Juniper Mine pose an imminent threat to human health and ecological receptors. Gamma radiation, associated with the emitter Ra-226, is present at the Juniper Mine at activities up to three orders of magnitude above the EPA excess radiation dose limit for protection of humans working or recreating at the site. Waste rock at the site contains radionuclides (U-235, U-238, Th-228, and Ra-226) up to four orders of magnitude above SSLs for protection of humans recreating at the site. Waste rock also contains uranium and Ra-226 from one to two orders of magnitude above benchmarks for protection of ecological receptors. Radon gas (a decay product of Ra-226) emitting from waste rock and low grade ore within the mine pit has been modeled at up to two orders of magnitude above background and an order of magnitude above the EPA indoor action level. Surface water and groundwater are also impacted by the release of radionuclides from Juniper Mine, though at concentrations that do not pose an imminent threat to human health and ecological receptors. Sediment in Pit and Red Rock Creeks contains radionuclides (Ra-226) up to two orders of magnitude above SSLs for protection of humans recreating at the site. A summary of response action criteria from the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) that are met at Juniper Mine are described below.

NCP Response Action Criteria. The potential risks to humans and ecological receptors described above document attainment of the following NCP response action factors found at 40 Code of Federal Regulations (CFR) Section 300.415(b)(2):

i. *Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants*. Radionuclides and metals are present in soil, surface water, sediment, and groundwater at and downstream of the site at concentrations that pose a carcinogenic risk exceeding the upper end of the risk range (10^{-4}) requiring a response action at the mine. The site and downstream meadow are used for year round recreation. Summer cabins are located within approximately 1 mile of the mine. The widely used Pacific Crest Trail is located approximately 8 miles due east and the Emigrant Wilderness is located approximately 3 miles southeast of the mine. Cattle and game use the meadow below the mine for grazing, potentially bioaccumulating radionuclides and metals in muscle for human consumption.

ii. *Actual or potential contamination of drinking water supplies or sensitive ecosystems.* Surface water and sediment discharged from the mine pit and waste rock piles has migrated into Red Rock Creek. The creek may be used as a source of drinking water at primitive campsites within the meadow below the mine. The creek is also a tributary to the Middle Fork Stanislaus River, a public drinking water supply. Radionuclides and metals are present in surface water and sediment at and downstream of the site at concentrations that pose a carcinogenic risk within the risk range (10^{-5}) potentially requiring a response action at the mine. The concentrations of radionuclides and metals exceed federal MCLs.

iv. *High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate.* Low grade uranium ore is exposed in the mine pit. Uranium and associated radionuclides are exposed at the surface of waste rock piles around the perimeter of the mine pit. Minimal vegetation covers the over steep slopes of the waste rock piles and walls within the mine pit. The low grade ore and waste rock has been observed to erode and migrate off-site during storms. The materials are also subject to wind erosion. Potential receptors and pathways are identified in factors (i) and (ii) above.

v. *Weather conditions, where the severity of the storm event can affect the severity of the release.* Low grade ore and waste rock is subject to erosion during storms and snow melt. The snow pack during the winter of 2004/2005 was over 30 feet at Relief Reservoir, east of the mine. Rapid snow melt, rain on snow events, and summer thunderstorms are known to cause substantial erosion at the site. A large amount of mobile sediment containing elevated concentrations of radionuclides was generated during a summer thunderstorm (see photographs in Appendix C).

vii. *No other response mechanism is available as the site is located on federal land managed by USFS and no other federal entity has the authority to respond.*

Based upon these three NCP factors, a response action is necessary at Juniper Mine to prevent human and ecological exposure to high levels of gamma radiation, radionuclides, and radon gas; to prevent the continued migration of radionuclides in sediment from Juniper Mine to the Red Rock Creek watershed; to reduce the mass of radionuclides in surface water discharging to the Red Rock Creek watershed; to reduce physical hazards associated with the pit high wall; and to reduce the potential uptake of radionuclides by wildlife and cattle through ingestion of plants that bioaccumulate radionuclides, incidental ingestion soil containing radionuclides during grazing, and consumption of surface water containing uranium and Ra-226 in the vicinity of Juniper Mine.

TABLE 4-1

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SOIL AND WASTE ROCK
JUNIPER MINE
(Page 1 of 3)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Waste Rock Pile No.1	SL-1, SL-8	**3.67 x 10-4**	Ra-226 (no other isotopes analyzed)	7.06 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from waste rock is above the risk range for radionuclides and in the middle portion of the risk range for metals. However, arsenic is at the upper end of the range of background concentrations.
Waste Rock Pile No.1 composite (leachate)	S-WR1-C	Not evaluated	Not evaluated	7.00 x 10-6	Leachable arsenic, uranium	Risk associated with ingestion of leachate that discharges to surface water or groundwater is in the lower portion of the risk range for metals. Radioistopes were not evaluated in this leachate sample. Waste rock leaches uranium, thorium, arsenic, and lead; none of the leachate values exceeded their STLC.
Waste Rock Pile No.2 hotspot	SL-2	**8.85 x 10-3**	Uranium and Ra-226 (no other isotopes analyzed)	4.12 x 10-5	Arsenic, uranium	Risk associated with ingestion, inhalation, and external irradiation from waste rock is above the risk range for radionuclides and in the upper portion of the risk range for metals.
Waste Rock Pile No.2 hotspot	S-WR2-G	**2.33 x 10-3**	Uranium, U-234, U-235, U-238, Th-228, Th-230, Ra-226, Ra-228, and Po-210	1.22 x 10-6	Uranium	Risk associated with ingestion, inhalation, and external irradiation from waste rock is above the risk range for radionuclides and in low end of the risk range for metals. Arsenic was not evaluated in this sample.
Waste Rock Pile No.2 composite (leachate)	S-WR2-C	Not evaluated	Not evaluated	Less than 1.00 x 10-6	None	Risk associated with ingestion of leachate that discharges to surface water or groundwater is below the risk range for metals. Radioistopes were not evaluated in this leachate sample. Waste rock leaches uranium, thorium, and cadmium. None of the leachate values exceeded their STLC.
Waste Rock Pile No.3	SL-3	5.11 x 10-5	Ra-226 (no other isotopes analyzed)	2.66 x 10-5	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from waste rock is in the upper portion of the risk range for radionuclides and above the middle portion of the risk range for metals. The concentration of Ra-226 is just slightly above background.

TABLE 4-1

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SOIL AND WASTE ROCK
JUNIPER MINE
(Page 2 of 3)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Waste Rock Pile No.3 composite (leachate)	S-WR3-C	Not evaluated	Not evaluated	1.27 x 10-6	Leachable arsenic	Risk associated with ingestion of leachate that discharges to surface water or groundwater is at the low end of the risk range for metals. Radioistopes were not evaluated in this leachate sample. Waste rock leaches uranium, thorium, arsenic, cadmium, and lead; none of the leachate values exceeded their STLC.
Waste Rock Pile No.3 average	WR3-1, WR3-2, WR3-3	1.53 x 10-5	Ra-226 and Th-228	2.76 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from waste rock is in the middle portion of the risk range for radionuclides and in the lower portion of the risk range for metals. The concentration of Ra-226 is below background. The concentration of arsenic is also within the range of background concentrations. Waste rock leaches radioisotopes at a cumulative risk of 2.39 x 10-7. None of the leachate values exceeded their STLC.
Composite of all three waste rock piles.	S-WR-C	**4.77 x 10-4**	Uranium, U-234, U-235, U-238, Th-230, Ra-226, Ra-228, Pb-210	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from waste rock is above the risk range for radionuclides and below the risk range for metals. Arsenic was not evaluated in this sample.
Mine Pit	SL-PIT	**1.92 x 10-3**	Ra-226 (no other isotopes analyzed)	1.52 x 10-5	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from waste rock is above the risk range for radionuclides and in the middle portion of the risk range for metals.
Background Soil North of Waste Rock Pile No.1	SL-4S, SL-4B	2.73 x 10-5	Ra-226 (no other isotopes analyzed)	6.58 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from soils is in the middle portion of the risk range for radionuclides and lower portion of the risk range for metals. This sample represents background for Ra-226 and the upper end of the range of background concentrations for arsenic.

TABLE 4-1

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SOIL AND WASTE ROCK
JUNIPER MINE
(Page 3 of 3)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Background Soil West of Waste Rock Pile No.3	SL-5S, SL-5B	2.73 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from soils is in the middle portion of the risk range for radionuclides and below the risk range for metals. **This sample represents background for Ra-226.**
Background Soil Above Confluence of Pit Creek and Red Rock Creek	SL-6S, SL-6B	2.73 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from soils is in the middle portion of the risk range for radionuclides and below the risk range for metals. **This sample represents background for Ra-226.**
Background Soil Southeast of Mine Site	SL-7S, SL-7B	1.11 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from soils is in the middle portion of the risk range for radionuclides and below the risk range for metals. **This sample represents background for Ra-226.**

Notes:

Pb-210	Lead-210
Ra-226	Radium-226
Ra-228	Radium-228
STLC	Soluble threshold limit concentration
Th-228	Thorium-228
Th-230	Thorium-230
U-234	Uranium-234
U-235	Uranium-235
U-238	Uranium-238

TABLE 4-2

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SURFACE WATER AND GROUNDWATER
JUNIPER MINE
(Page 1 of 3)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Lower Red Rock Creek Meadow	LC2	6.82 x 10-7	None	Less than 1.00 x 10-6	None	Risk associated with ingestion of surface water is below risk range for both radionuclides and metals.
Middle Red Rock Creek Meadow	M2	4.51 x 10-7	None	Less than 1.00 x 10-6	None	Risk associated with ingestion of surface water is below risk range for both radionuclides and metals.
End of Red Rock Creek Canyon	UC2	7.82 x 10-7	None	Less than 1.00 x 10-6	None	Risk associated with ingestion of surface water is below risk range for both radionuclides and metals.
Below Confluence of Pit Creek and Red Rock Creek	UC1	4.89 x 10-6	U-234, U-238	2.57 x 10-6	Uranium	The concentrations of uranium and the isotopes U-234 and U-238 exceed their MCL. The concentrations of the two isotopes in the creek also exceed groundwater concentrations within the ore body. However, risk associated with ingestion of surface water is in the lower portion of the risk range for both radionuclides and metals.
Pit Creek at Forest Road 5N33	PC1	7.81 x 10-6	U-234, U-238	5.33 x 10-6	Uranium	The concentrations of uranium and the isotopes U-234 and U-238 exceed their MCL. The concentrations of uranium and the two isotopes in the creek also exceed groundwater concentrations within the ore body. However, risk associated with ingestion of surface water is in the lower portion of the risk range for both radionuclides and metals.
Seep at Base of Waste Rock Pile No.2	WR2	1.52 x 10-5	U-234, U-238, Ra-226, Pb-210	7.00 x 10-6	Uranium	The concentrations of uranium and all four isotopes exceed their MCL. The concentrations of uranium and the U-234 and U-238 in the seep also exceed groundwater concentrations within the ore body. However, risk associated with ingestion of spring water is in the middle of the risk range for both radionuclides and metals.
Pit Spring	PS	4.10 x 10-5	U-234, U-238, Ra-226, Pb-210	2.70 x 10-6	Uranium	The concentrations of uranium and all four isotopes exceed their MCL. The concentrations of U-234, U-238, and Pb-210 in spring water also exceed groundwater concentrations within the ore body. However, risk associated with ingestion of spring water is in the upper portion of the risk range for radionuclides and in the lower portion for metals.

TABLE 4-2

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SURFACE WATER AND GROUNDWATER
JUNIPER MINE
(Page 2 of 3)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Spring North of Waste Rock Pile No.1	WR1	1.45 x 10-6	None	2.85 x 10-6	Thallium	The concentration of thallium slightly exceeds its MCL. Thallium was only detected in this one sample at the site at just above the method detection limit. The risk associated with ingestion of spring water is in the lower portion of the risk range for both radionuclides and metals.
Upgradient Monitoring Well	MW-1	1.92 x 10-5	U-234, U-238, Ra-226, Pb-210	1.94 x 10-5	Arsenic, beryllium, chromium, lead, and uranium	The concentrations of arsenic, beryllium, chromium, lead, uranium, and all four isotopes exceed their MCL. However, risk associated with ingestion of groundwater (if extracted) is in the middle portion of the risk range for both radionuclides and metals. The concentrations of U-234, U-238, Ra-226 and Pb-210 are naturally occurring due to groundwater interaction with the intact ore body.
Downgradient Monitoring Well	MW-2	9.98 x 10-6	U-234, U-238	2.20 x 10-6	Uranium	The concentrations of uranium and the two isotopes exceed their MCL. The risk associated with ingestion of groundwater (if extracted) is in the middle of the risk range for radionuclides and in the lower portion for metals. However, the concentrations of uranium, U-234, and U-238 in the groundwater downgradient of the site are less than their concentrations within the ore body.
Spring at Head of Sardine Meadow	W-BG	3.04 x 10-8	None	Less than 1.00 x 10-6	None	Risk associated with ingestion of surface water is below risk range for both radionuclides and metals. The concentration of radionuclides and metals in spring water are not comparable to site concentrations because the groundwater is not in contact with the naturally occurring ore body.
Tributary to Red Rock Creek above Mine	W-BUC	5.22 x 10-8	None	Less than 1.00 x 10-6	None	Risk associated with ingestion of surface water is below risk range for both radionuclides and metals. The concentration of radionuclides and metals in the creek are not directly comparable to site concentrations because the creek is not in contact with the ore body or receiving discharge from groundwater in contact with the ore body.

TABLE 4-2

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH SURFACE WATER AND GROUNDWATER
JUNIPER MINE
(Page 3 of 3)

Notes:

MCL	Maximum contaminant level
Pb-210	Lead-210
Ra-226	Radium-226
U-234	Uranium-234
U-238	Uranium-238

TABLE 4-3

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH CREEK AND OUTWASH AREA SEDIMENT
JUNIPER MINE
(Page 1 of 2)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Red Rock Creek below Haypress Lake	SD-3	3.72 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from sediment is in the middle portion of the risk range for radionuclides and below the risk range for metals. The concentration of Ra-226 is just slightly above background.
Lower Red Rock Creek Meadow	SD-6	5.03 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from sediment is in the middle portion of the risk range for radionuclides and below the risk range for metals. The concentration of Ra-226 is about twice background.
Lower Red Rock Creek Meadow	LC-SED	3.01 x 10-5	Ra-226, Th-228	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from sediment is in the middle portion of the risk range for radionuclides and below the risk range for metals. The concentration of Ra-226 is within the range of background concentrations.
Middle Red Rock Creek Meadow	SD-2	4.73 x 10-5	Ra-226 (no other isotopes analyzed)	3.07 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from sediment is in the middle portion of the risk range for radionuclides and in the lower portion of the risk range for metals. The concentration of Ra-226 is about twice background.
Middle Red Rock Creek Meadow	MM-SED	3.59 x 10-5	Ra-226, Th-228	1.28 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from sediment is in the middle portion of the risk range for radionuclides and in the lower portion of the risk range for metals. The concentration of Ra-226 is just slightly above background.
Upper Red Rock Creek Meadow	UM-SED	4.02 x 10-5	Ra-226, Th-228	1.15 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from sediment is in the middle portion of the risk range for radionuclides and in the lower portion of the risk range for metals. The concentration of Ra-226 is just slightly above background.

TABLE 4-3

RADIONUCLIDE AND METALS RISK ASSOCIATED WITH CREEK AND OUTWASH AREA SEDIMENT
JUNIPER MINE
(Page 2 of 2)

Sample Location	Sample Number	Radionuclides	COPC	Metals	COPC	Risk Screening Comments
Upper Red Rock Creek Canyon	UC-SED	**1.28 x 10-4**	U-238, Ra-226, Th-228, Pb-210	2.68 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from sediment is above the risk range for radionuclides and in the middle portion of the risk range for metals.
Upper Red Rock Creek Canyon (leachate)	UC-SED	5.26 x 10-6	Pb-210	1.9 x 10-6	Thallium	Risk associated with ingestion of leachate that discharges to surface water is at the low end of the risk range for both radionuclides and metals. None of the leachate values exceeded their STLC.
Pit Creek at Forest Road 5N33	SD-1	**2.14 x 10-4**	Ra-226 (no other isotopes analyzed)	4.4 x 10-6	Arsenic	Risk associated with ingestion, inhalation, and external irradiation from sediment is above the risk range for radionuclides and in the lower portion of the risk range for metals.
Background Sediment, Upper Red Rock Creek, southeast of mine	SD-4B	2.62 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from soils is in the middle portion of the risk range for radionuclides and below the risk range for metals. ***This sample represents background for Ra-226.***
Background Sediment, Upper Red Rock Creek, south of mine	SD-5B	2.01 x 10-5	Ra-226 (no other isotopes analyzed)	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from soils is in the middle portion of the risk range for radionuclides and below the risk range for metals. ***This sample represents background for Ra-226.***
Background Sediment, tributary to Red Rock Creek above Mine	BUC-SED	4.85 x 10-6	Ra-226	Less than 1.00 x 10-6	None	Risk associated with ingestion, inhalation, and external irradiation from soils is in the lower portion of the risk range for radionuclides and below the risk range for metals. ***This sample represents background for Ra-226.***

Notes:

Pb-210	Lead-210	STLC	Soluble threshold limit concentration	U-238	Uranium-238
Ra-226	Radium-226	Th-228	Thorium-228		

5.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section identifies and evaluates potential federal and State of California ARARs and sets forth USFS's determinations regarding those potential ARARs for each response action alternative retained for detailed analysis in this EE/CA. Section 5.1 summarizes the definitions and concepts pertinent to ARAR determinations. The three categories of ARARs, chemical-, location- and action-specific, are described in Sections 5.2, 5.3, and 5.4, respectively. Section 5.5 follows the ARAR discussion and provides an analysis of the exemption of mining wastes from regulation as a hazardous waste under Section 3001(a)(3)(A)(ii) of the Resource Conservation and Recovery Act (RCRA) (Bevill Amendment) and under the California Health and Safety Code, Section 25143.1(b)(1) and (2).

USFS has primary responsibility for identifying federal ARARs at Juniper Mine. USFS has identified the following federal and state ARARs for the Juniper Mine.

5.1 SUMMARY OF COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT AND NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTIGENCY PLAN REQUIREMENTS

Section 121(d) of the CERCLA of 1980 (42 *United States Code* [USC] Section 9621[d]), as amended, states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the law or regulation directly address the circumstances at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR, only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site (EPA

1988a). A requirement must be determined to be both relevant <u>and</u> appropriate to be considered an ARAR.

The criteria for determining relevance and appropriateness, as listed in 40 CFR Section 300.400(g)(2), are:

Purpose of the requirement and the purpose of the CERCLA action

- Medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site
- Substances regulated by the requirement and the substances found at the CERCLA site
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site
- Type of place regulated and the type of place affected by the release or CERCLA action
- Type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site

A requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs is done on a site-specific basis and involves a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA 1988b).

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be:

- A state law
- An environmental or facility siting law
- Promulgated (of general applicability and legally enforceable)
- Substantive (not procedural or administrative)

- More stringent than the federal requirement
- Identified in a timely manner
- Consistently applied

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Permits are considered to be procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or nonenvironmental, including permit requirements, are not considered to be ARARs.

Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful, and are "to be considered" (TBC). TBC (40 CFR 300.400[g][3]) requirements complement ARARs but do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

Additional general information regarding ARARs may be found in EPA's *CERCLA Compliance with Other Laws Manual* (August 1989). Specific ARARs issues are also discussed in the March 8, 1990, Federal Register notice publishing the final rule for the National Contingency Plan (See 55 Federal Register 8666, et seq.)

USFS has developed three categories of ARARs to assist in the identification of ARARs. The three categories are (1) chemical-specific, (2) location-specific, (3) and action-specific ARARs. EPA guidance recognizes that some requirements do not fall neatly into this classification. These categories are described in the following sections.

5.2 CHEMICAL SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDEREDS

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in the establishment of a cleanup level. The four media of potential concern at Juniper Mine are:

- Groundwater
- Surface water
- Waste rock, exposed ore, and sediment
- Air

Potential ARARs for these media are evaluated below.

5.2.1 Groundwater Applicable or Relevant and Appropriate Requirements

The identification of ARARs for groundwater depends on whether the groundwater is a potential drinking water source. Under the EPA's Guidelines for Groundwater Classification, groundwater is considered a potential drinking water source unless there is insufficient quality (TDS concentrations are over 10,000 milligram per liter [mg/L]) or quantity (well yield is less than 150 gallons per day). Under the State of California's Sources of Drinking Water Policy, State Water Resources Control Board (SWRCB) Resolution No. 88-63, groundwater is considered a potential drinking water source if the TDS levels are below 3,000 mg/L and the well yield is less than 200 gallons per day. Groundwater at Juniper Mine meets both the state and federal criteria for quality, but does not meet either yield criteria due to topographic position (top of the mountain), thinness of the soil mantle over the rhyodacite tuff, and lack of a continuous, effective water bearing zone. Yield observed during development of 4 inch wells in 2004 was less than 1 gpm. Discharge from the mine pit ranges from is less than 10 to 20 gpm. The closest potential consumer of groundwater for drinking water purposes is approximately 2 miles east of the mine, at the summer cabins around Haypress Lake. However, the summer cabins are situated up gradient of Red Rock Creek, the only creek draining groundwater from Red Rock Meadow.

SWRCB Resolution No. 88-63 exempts those surface waters and groundwaters from municipal or domestic supply where "there is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use using either Best Management Practices or best economically achievable treatment practices." Groundwater at Juniper Mine contains uranium and other radionuclides due to natural pre-mining contact of groundwater with the natural ore body, making it a poor source of drinking water. Treatment of groundwater to remove natural levels of uranium and other radionuclides is not economically feasible and is prohibited under CERCLA 104(a)(3)(A).

The text of CERCLA 104(a)(3)(A) reads as follows:

§9604. Response authorities

(a) Removal and other remedial action by President; applicability of national contingency plan; response by potentially responsible parties; public health threats; limitations on response; exception

(3) Limitations on Response. - The President shall not provide for a removal or remedial action under this section in response to a release or threat of release –

(A) of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found…

Therefore, while the following requirements are ARAR to groundwater at Juniper Mine, COCs in waste leaching to groundwater will be treated to local, naturally-occurring groundwater concentrations if the effluent is discharged to groundwater. However, if the effluent is discharge to surface water, then the COCs must be treated to their respective MCLs.

The following regulation is not applicable, but is a relevant and appropriate federal requirement for protection of groundwater underlying Juniper Mine:

C Safe Drinking Water Act (SDWA) (42 USC Section 300f et seq.)

The following regulations are applicable state requirements for protection of groundwater underlying Juniper Mine:

C Central Valley Regional Water Quality Control Board (RWQCB) Basin Plan water quality objectives (WQO)

C SWRCB Resolution 68-18, Statement of Policy With Respect to Maintaining High Quality Waters in California

C SWRCB Resolution 92-49, Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under California Water Code Section 13304

Each of these ARARs is discussed below.

5.2.1.1 Safe Drinking Water Act

The SDWA, 42 USC Section 300f et seq., sets limits on the concentrations of certain hazardous materials in drinking water. MCLs are applied at the tap to water that is delivered directly to 25 or more people or

to 15 or more service connections. These requirements are not met at Juniper Mine or downstream locations; therefore the SDWA is not an applicable requirement, but may be relevant and appropriate for protection of beneficial uses. Under the SDWA, EPA has also designated maximum contaminant level goals (MCLGs), which are health-based goals, generally more stringent than MCLs.

USFS has identified MCLs (40 CFR 141.62(b)) or MCLGs (40 CFR 141.51) as relevant and appropriate for the following COCs detected in groundwater at Juniper Mine:

Chemical of Concern	MCL	MCLG
Total Uranium	30 μg/L	0 μg/L
Radium-226	5 pCi/L	0 pCi/L

5.2.1.2 Central Valley Water Quality Control Plan (Basin Plan)

The Basin Plan for the Central Valley (SWRCB 1995), including the Upper Stanislaus River watershed, was prepared and implemented by the Central Valley RWQCB to protect and enhance the quality of waters in the region. The Basin Plan establishes location-specific beneficial uses and WQOs for surface water and groundwater of the region. The Basin Plan includes both numeric and narrative WQOs. The WQOs are intended to protect the beneficial uses of the water of the region and to prevent nuisance.

The Basin Plan contains the following pertinent narrative WQOs for groundwater:

> *Chemical Constituents: Groundwater shall not contain chemical constituents in concentrations that adversely affect beneficial uses.*
>
> *Toxics: Groundwater shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life associated with designated beneficial uses.*

5.2.1.3 State Water Resources Control Board Resolution 68-16

Resolution 68-16, Statement of Policy With Respect to Maintaining High Quality Waters in California, establishes the policy that high quality waters of the state "shall be maintained to the maximum extent possible" consistent with the "maximum benefit to the people of the state." It requires the maintenance of high quality waters until it has been demonstrated that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect beneficial uses of such water, and will comply with applicable water quality control policies. It further requires that any discharge of waste to

high quality waters comply with requirements resulting in best practicable treatment or control to prevent pollution or nuisance.

5.2.1.4 State Water Resources Control Board Resolution 92-49

SWRCB Resolution 92-49 contains policies and procedures that the regional boards apply to all investigations and cleanup and abatement activities for all types of discharges subject to Water Code Section 13304. Section III.G of the Resolution requires attainment of background water quality, or if background cannot be restored, the best water quality that is reasonable.

5.2.2 Surface Water Applicable or Relevant and Appropriate Requirements

As with groundwater, the identification of surface water ARARs also hinges on the beneficial uses of the water. In the Basin Plan, the existing beneficial uses for the Upper Stanislaus River and tributaries are municipal domestic supply, agriculture, recreation, warm freshwater habitat, spawning, and wildlife habitat. The closest potential consumer of surface water for drinking water purposes is approximately 2 miles east of the mine, at the summer cabins around Haypress Lake. However, the summer cabins are situated up gradient of Red Rock Creek, the only creek draining groundwater from Red Rock Meadow.

SWRCB Resolution No. 88-63 exempts those surface water and groundwaters from municipal or domestic supply where "there is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use using either Best Management Practices or best economically achievable treatment practices." The source of surface water at Juniper Mine is natural groundwater that contains uranium and other radionuclides due to natural pre-mining contact of groundwater with the natural ore body, making it a poor source of drinking water. Treatment of surface water bodies at Juniper Mine to remove natural levels of uranium and other radionuclides whose source is natural groundwater is not economically feasible and is prohibited under CERCLA 104(a)(3)(A) (see citation in Section 5.2.1 above).

Therefore, while the following requirements are ARAR to surface water, COCs in surface water at and discharging from Juniper Mine will be treated to local, naturally-occurring groundwater concentrations if the effluent is discharged to groundwater. However, if the effluent is discharge to surface water, then the COCs must be treated to their respective MCLs.

The following regulations are not applicable, but are relevant and appropriate federal and state requirements for protection of surface water at and discharging from Juniper Mine:

- Safe Drinking Water Act (42 USC Section 300f et seq.)
- California Safe Drinking Water Act of 1976 (22 California Code of Regulations [CCR] Sections 64431 and 64449(a))

The following regulations are applicable state requirements for protection of surface water at and discharging from Juniper Mine:

- RWQCB Basin Plan WQOs
- SWRCB Resolution 68-18, Statement of Policy With Respect to Maintaining High Quality Waters in California
- SWRCB Resolution 92-49, Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under California Water Code Section 13304

SWRCB Resolution 68-16 and 92-49 are discussed in Sections 5.2.1.3 and 5.2.1.4 above for groundwater. The federal and state Safe Drinking Water Acts and the Basin Plan for surface waters are discussed below.

5.2.2.1 Safe Drinking Water Act

The SDWA, 42 USC Section 300f et seq., sets limits on the concentrations of certain hazardous materials in drinking water. MCLs are applied at the tap to water that is delivered directly to 25 or more people or to 15 or more service connections. These requirements are not met at Juniper Mine or downstream locations; therefore the SDWA is not an applicable requirement, but may be relevant and appropriate for protection of beneficial uses. Under the SDWA, EPA has also designated MCLGs, which are health-based goals, generally more stringent than MCLs.

USFS has identified MCLs (40 CFR 141.62(b)) or MCLGs (40 CFR 141.51) as relevant and appropriate for the following COCs detected in surface water at Juniper Mine:

Chemical of Concern	MCL	MCLG
Total Uranium	30 µg/L	0 µg/L
Radium-226	5 pCi/L	0 pCi/L

5.2.2.2 State Safe Drinking Water Act

The state of California has adopted primary and secondary MCLs for public drinking water under the California Safe Drinking Water Act of 1976. Some state MCLs may be more stringent than the corresponding federal MCL, in which case the state MCL would generally be the ARAR. The MCLs are set forth in 22 CCR Sections 64431 and 64449(a). Because the California SDWA also applies to tap water (see federal SDWA above) it is not an applicable requirement, but may be relevant and appropriate for protection of beneficial uses. USFS has identified MCLs as relevant and appropriate for the following COCs detected in surface water at Juniper Mine:

Chemical of Concern	Primary MCL	Secondary MCL
Total Uranium	30 μg/L	None
Radium-226	5 pCi/L	None

5.2.2.3 Central Valley Water Quality Control Plan (Basin Plan)

The Basin Plan identifies MCLs as the standard for surface water drinking water sources. The Basin Plan also includes narrative WQOs for surface water within the region. The WQOs potentially pertinent to the response action at Juniper Mine are as follows:

> *Suspended material: Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.*
>
> *Toxics: Water shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.*

5.2.3 Waste Rock, Exposed Ore Body, and Sediment ARARs

No federal or state chemical-specific ARARs have been identified for waste rock, exposed ore body, and sediment at Juniper Mine.

5.3 LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDEREDS

Location-specific ARARs are restrictions on the concentrations of hazardous substances on the conduct of activities solely because they are in specific locations. Special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. The Archeological and Historic Preservation Act,

the Fish & Wildlife Coordination Act, and various California natural resource laws are potential ARARs. Each is summarized below.

5.3.1 Archeological and Historic Preservation Act

The Archeological and Historic Preservation Act, 16 USC Section 469, establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. If any response action would cause irreparable loss or destruction of significant scientific, prehistoric, historical, or archeological data, it will be necessary to follow the procedures in the statute to provide for data recovery and preservation activities. A request for a sacred lands file check has been prepared and submitted to the Native American Heritage Commission. Additionally, the California State Office of Historic Preservation was contacted for any historical or archeological information regarding the Juniper Mine site. No sacred lands or historical or archeological resources were reported.

5.3.2 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act, 16 USC Section 661 et seq., was enacted to protect fish and wildlife when federal actions result in the control or structural modification of a natural stream or body of water. The statute requires federal agencies to take into consideration the effect that water-related projects would have upon fish and wildlife and then take action to prevent loss or damage to these resources.

5.3.3 Migratory Bird Treaty Act

The Act, 16 USC Section 703, establishes federal responsibility for the protection of international migratory bird resources. It prohibits at any time, using any means or manner, the pursuit, hunting, capturing, killing or attempting to take, capture, or kill any migratory bird. No migratory birds have been identified at the site.

5.3.4 California Natural Resource Laws

No threatened or endangered species have been identified at the site. Nevertheless, other Fish & Game code provisions protect aquatic and wildlife species and their habitat and are evaluated as potential

ARARs. Fish & Game Code Section 3005 prohibits the taking of any mammal or bird with poison. Fish & Game Code Section 5650 makes it unlawful to "deposit in, permit to pass into, or place into waters of the state . . . substance or material deleterious to fish, plant life, or bird life."

5.4 ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDEREDS

Action-specific ARARs are technology- or activity-based requirements of limitations on actions taken with respect to hazardous substances. These requirements are triggered by the particular remedial activities selected. This section summarizes the general action-specific ARARs for the alternatives. A more detailed discussion of the action-specific ARARs as they apply to each alternative is included in Section 8.0, as part of the detailed analysis of the alternatives.

For alternatives that involve the excavation/extraction, treatment and/or disposal of contaminated media, the following regulations were evaluated as ARARs.

5.4.1 Tuolumne County Air Pollution Control District Regulations

Tuolumne County Air Pollution Control District (APCD) rules and regulations include standards for nuisances. Specifically, Rule 205 prohibits the discharge of air contaminants (e.g., dust) causing nuisances.

5.4.2 Resource Conservation and Recovery Act

Section 3001(b) of the RCRA temporarily prohibited EPA from regulating solid waste from the "extraction, beneficiation, and processing of ores and minerals" as hazardous waste pending further study. EPA has since determined that regulation of many of the wastes from mineral extraction do not warrant regulation as hazardous waste. Specifically, 22 CCR Section 66261.4(b)(5)(A) excludes "solid waste from the extraction, beneficiation, and processing of ores and minerals" from the definition of hazardous waste.

All of the wastes generated at the site relate in some manner to historic mining operations at the site. Accordingly, the requirements for control of such wastes are of great importance in controlling the releases at Juniper Mine. This part concludes that the mining wastes at Juniper Mine are not subject to RCRA Subtitle C regulation or generally subject to regulation as hazardous wastes under the California

Hazardous Waste Control Law. The wastes would, however, be regulated under the provisions of California Water Code Section 13172. The level of control required under state law will depend upon whether the wastes are classified as Group A, B, or C wastes.

The waste sources and potential waste sources at Juniper Mine include:

- Waste rock piles and associated sediment, surface water, groundwater, dust, gamma radiation, and radon gas
- Mine pit and associated sediment, surface water, dust, gamma radiation, and radon gas

Because of the similarity between the mining wastes and RCRA characteristically hazardous wastes, some RCRA and California Hazardous Waste Control Law requirements for hazardous waste may be relevant and appropriate even if not directly applicable to these wastes.

5.4.3 Clean Water Act

The Clean Water Act (CWA) contains permit requirements for discharges to waters of the United States. For those alternatives that would involve discharge to surface water, the substantive requirements of 40 CFR Part 122 are potential ARARs.

5.4.4 Clean Water Act Permit Requirements for Stormwater Discharges

Any on-site discharge of storm water runoff associated with construction of the proposed remedy must meet the substantive requirements of the General National Pollutant Discharge Elimination System (NPDES) Permit for Stormwater Discharges Associate with Construction Activity, Order No. 99-08-DWQ, issued by the SWRCB pursuant to is delegated authority under the CWA. In addition, the substantive requirements of the General Permit for Stormwater Discharges associated with Industrial Activities, Order No. 97-03-DWQ, may be potential ARARs because inactive mines are considered to be an industrial activity for purposes of the permit.

5.5 MINING WASTE REGULATIONS

All of the waste streams noted above are the result of mineral extraction or beneficiation at the site. Under RCRA Section 3001(a)(3)(A)(ii), 42 USC 6921(a)(3)(A)(ii) (also known as the "Bevill amendment"), EPA has exempted most mining wastes from regulation as hazardous waste. Exempted waste includes waste from the extraction and beneficiation of minerals, and some mineral processing wastes. See 40 CFR Section 261.4(b)(7).

Under the Bevill exclusion, many solid wastes that would otherwise be characteristically hazardous would not qualify as hazardous wastes. The Bevill exclusion, codified at 40 CFR, Part 261.4(b)(7), provides that "[s]olid waste from the extraction, beneficiation and processing of ores and minerals (including coal), including phosphate rock and overburden from the mining of uranium ore [are not hazardous wastes]. For purposes of this paragraph, beneficiation of ores and minerals is restricted to the following activities: crushing, grinding, washing, dissolution, crystallization, filtration, sorting, sizing, drying, sintering, pelletizing, briquetting, calcining to remove water and/or carbon dioxide, roasting in preparation for leaching...gravity concentration, magnetic separation, electrostatic separation, floatation [sic], ion exchange, solvent extraction, electrotwinning, precipitation, amalgamation, and heap, dump, vat, tank, and in situ leaching."

5.5.1 State Exclusion of Mining Waste from Regulation as Hazardous Waste

California's Health and Safety Code recognizes the Bevill exclusion, so that wastes that would otherwise be regulated by the California Hazardous Waste Control Law, the California analogue to RCRA, are instead subject only to the requirements of Water Code Section 13172, detailed in 27 CCR Section 22470 et seq. Under Health and Safety Code Section 25143.1(b)(1 & 2),

> "Wastes from the extraction, beneficiation, and processing of ores and minerals that are not subject to regulation under Subchapter III (commencing with Section 6921) of Chapter 82 of Title 42 USC are exempt from the requirements of this chapter, except the requirements of Article 9.5 (commencing with Section 25208) and Chapter 6.8 (commencing with Section 25300)....The wastes subject to this subdivision are subject to Article 9.5 (commencing with Section 25208) and Chapter 6.8 (commencing with Section 25300) if the wastes would otherwise be classified as hazardous wastes pursuant to Section 25117 and the regulations adopted pursuant to Section 25141."

5.5.2 Surface Mining Control and Reclamation Act

The Surface Mining Control and Reclamation Act (SMCRA), 30 USC Section 1201 et seq., establishes a nationwide program for the protection of human health and the environment from the adverse effect of surface coal mining operations. Although SMCRA addressed abandoned coal mines, it may be relevant and appropriate to cleanup of other types of mining sites. In its CERCLA Compliance with Other Laws Manual, EPA explained that SMCRA may be relevant and appropriate at (1) sites with sulfide-containing geologic materials and there is a release or threat of release of acid and at (2) sites subject to erosion and thus releases are contaminated by heavy metals. The following regulations, which provide guidelines for post-mining rehabilitation and reclamation of surface mines (Part 816) and underground mines (Part 817) may be potentially relevant and appropriate:

- 30 CFR 816.43/817.43 – standard for diversions of flow from disturbed areas
- 30 CFR 816.56/817.56 – post mining rehabilitation of sedimentation ponds, diversions, impoundments
- 30 CFR 816.97/817.97 – protection of fish and wildlife
- 30 CFR 816.111/817.11, 816.114/817.114, and 816.116/817.116 – revegetation requirements
- 30 CFR 816.132/817.132 – standards for cessation of operations

5.5.3 California Surface Mining and Reclamation Act of 1975

Pursuant to the state Surface Mining and Reclamation Act (SMARA), the California Department of Conservation, Office of Mine Reclamation has adopted reclamation standards for mining operations in Article 9, Title 14. These standards do not apply to operations that completed reclamation prior to January 15, 1993 or had an approved reclamation plan prior to January 15, 1993. Pertinent requirements include provisions of the follow regulations:

- 14 CCR 3703 – protection standards for wildlife habitat
- 14 CCR 3704 – performance standard for backfilling, re-grading, slope stability, and recontouring
- 14 CCR 3705 – performance standards for revegetation
- 14 CCR 3706 – performance standards for drainage, diversion structures, waterways, and erosion control

- 14 CCR 3710 – performance standards for stream protection
- 14 CCR 3713 – performance standards for closure of surface openings

5.5.4 California Mining Waste Regulations

Pursuant to California Water Code Section 13172, the state of California has adopted regulations designed to address the management of mining waste. These regulations are found at 27 CCR 22470-22510. The regulations establish three groups of mining waste:

- Group A – mining waste that the must be managed as hazardous waste provided the RWQCB finds that such mining wastes pose a significant threat to water quality
- Group B – mining wastes that consist of or contain hazardous wastes that qualify for a variance, provided that the RWQCB finds that such mining wastes pose a low risk to water quality, or mining wastes that consist of or contain nonhazardous soluble pollutants of concentrations which exceed WQOs for, or could cause, degradation of waters of the state
- Group C – wastes from which any discharge would be in compliance with the applicable water quality control plan, include WQOs other than turbidity

Classification of the mining waste as hazardous under the Hazardous Waste Control Act is used to determine which group designation is appropriate. The mining wastes from Juniper Mine are appropriately classified as Group A wastes. The regulations contain specific requirements on siting, construction, monitoring, and closure and post-closure maintenance of existing and new units. These requirements are ARAR for alternatives that involve the creation of an on-site disposal unit or closure of existing units.

Design and Siting under Water Code Section 13172

Under state regulations governing the design of mining waste disposal units, the RWQCB imposes specific requirements on siting, construction, monitoring, and closure and post-closure maintenance of existing and new Group A disposal units.

New Group A Units:

- Shall not be located on Holocene faults
- Shall be outside areas of rapid geologic change, but may be located there if containment structures are designed and constructed to preclude failure
- Flood protection—locate outside of 100-year flood plain

- Construction standards--for waste piles, the pile must be underlain with a single clay liner (at least 1 x 10^{-7} centimeters per second [cm/sec] permeability); a blanket-type leachate collection and recovery system (LCRS) is required

- Precipitation and drainage controls—designed to accommodate one 25-year, 24-hour storm; precipitation that is not diverted shall be collected and managed through the required LCRS, unless the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality standards. Precipitation and drainage controls shall comply with requirements in Section 20365 (d and e)

- Closure--final cover graded to be no steeper than 3 to 1 (vertical to horizontal) with minimum 15 feet wide benches for every fifty feet of vertical height; three layer (foundation, low permeability--1x10^{-6} cm/sec--layer, and erosion resistant layer) or alternative cover design.

- Monitoring--comply with conditions of 27 CCR Sections 20385-20430

Existing Group A Units:

- Flood Protection--protect from 100-year peak streamflow

- Construction standards--same as for new Group A units

- Precipitation and drainage controls—design to accommodate one 25-year, 24-hour storm; precipitation that is not diverted shall be collected and managed through a required LCRS, unless the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality standards

- Closure--final cover graded to be no steeper than 3:1 (vertical to horizontal) with minimum 15 feet wide benches for every fifty feet of vertical height; three layer (foundation, low permeability--1x10-6 cm/sec--layer, and erosion resistant layer) or alternative cover design.

- Monitoring--comply with conditions of 27 CCR Sections 20385-20430

More detailed information about these requirements is contained in 27 CCR Section 22490.

Variances. Under 27 CCR Section 22470(c), Group A wastes may be exempt from liner and a LCRS if a comprehensive hydrogeologic investigation demonstrates that natural conditions or containment structures will prevent lateral hydraulic interconnection with natural geologic materials containing groundwater suitable for agricultural, domestic, or municipal use and (1) there are only minor amounts of groundwater underlying the area, or (2) the discharge is in compliance with the applicable water quality control plan. The unit would remain subject to requirements for siting, precipitation and drainage controls, and groundwater, unsaturated zone and surface water quality monitoring.

In addition, 27 CCR Section 20080(b and c) provide for consideration of engineered alternatives to the prescriptive construction and closure standards of 27 CCR. Alternatives are to be considered when a demonstration is made that the prescriptive standard is not feasible and there is a specific engineered alternative that is consistent with the performance goal of the prescriptive standard, and affords equivalent protection against water quality impairment. Feasibility of the prescriptive standard is evaluated by determining if compliance would be unnecessarily burdensome and cost substantially more than engineered alternatives; or the prescriptive standard is impractical and will not promote attainment of applicable performance standards. In evaluating the feasibility, all relevant technical and economic factors such as present and projected costs, and the extent to which groundwater resources would be affected should be considered.

These exemptions to the prescriptive standards apply to closure of existing units and construction of new Group A units at Juniper Mine. Engineered alternatives, including water treatment, are described in Section 8.0.

6.0 RESPONSE ACTION OBJECTIVES AND GOALS

The goal of the EE/CA process at Juniper Mine is to develop and select remedies in accordance with CERCLA criteria. These criteria require that remedies be protective of human health and the environment and comply with ARARs (see Section 5.0). Preliminary response action objectives (PRAO) and preliminary response action goals (PRAG) have been developed for Juniper Mine in consideration of CERCLA criteria. The response action objectives and goals identified in this EE/CA are typical of those used for cleanup actions at abandoned mine sites. They will be refined and updated as additional information becomes available and the designation of COCs is finalized. The final response action objectives and final response action goals will be identified in the action memorandum.

6.1 PRELIMINARY RESPONSE ACTION OBJECTIVES

PRAOs for Juniper Mine include the following:

- Reduce risk due to ingestion and inhalation of mine wastes, surface water, groundwater, and sediment to acceptable levels for recreational visitors and terrestrial and aquatic biota
- Reduce risk due to exposure to gamma radiation from the mine pit, waste rock, and sediment to acceptable levels for recreational visitors and terrestrial and aquatic biota
- Minimize risk due to exposure to air emissions of radon from the mine pit, waste rock, and sediment to acceptable levels for recreational visitors
- Minimize off-site transport of COCs in surface water, groundwater, sediment, and dust to prevent either unacceptable risk to human health and environment or unacceptable degradation of surface and ground water resources
- Protect beneficial uses of surface and ground waters

6.2 PRELIMINARY RESPONSE ACTION GOALS

PRAGs for Juniper Mine include the following:

<u>Solid Media (Waste Rock Piles, Waste Rock Covered Roads, Exposed Ore Bearing Rock)</u>

- Reduce gamma radiation risk (due to Ra-226) to recreational visitors and terrestrial and aquatic biota to below the EPA <u>excess</u> dose limit of 15 mrem/year or 29 μR/hr (background plus 12 μR/hr, assuming a 52 day per year recreational exposure scenario)

- Reduce ingestion risk to recreational visitors and terrestrial and aquatic biota to the following benchmarks or less.

Chemical of Concern	Site Background	Unit	Human Health Benchmark	Source	Ecological Benchmark	Source
Arsenic	7 to 9.5	mg/kg	3.04	a	9.9	c
Uranium	4.9 to 5.6	mg/kg	1,064	a	5	c
Uranium-234	1.5 to 2.05	pCi/g	76	b	5,000	d
Uranium-235	0.077 to 0.153	pCi/g	3.1	b	3,000	d
Uranium-238	1.79 to 2.31	pCi/g	15	b	2,000	d
Thorium-228	0.92 to 0.98	pCi/g	0.81	b	NA	--
Thorium-230	2.18 to 2.83	pCi/g	60	b	NA	--
Radium-226	2.23 to 2.94	pCi/g	0.2	b	50	d
Radium-228	NA	pCi/g	0.64	b	40	d
Polonium-210	1.75 to 1.91	pCi/g	280	b	NA	--
Lead-210	1.78 to 2.21	pCi/g	5.0	b	NA	--

Notes:

a Calculated EPA Region 9 Preliminary Remediation Goal using site-specific exposure scenario (EPA 2004)
b Soil Screening Guidance for Radionuclides: User's Guide (EPA 2000)
c EPA Region IV Soil Benchmark (EPA 2001)
d A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE 2002)
EPA = U.S. Environmental Protection Agency
mg/kg = Milligrams per kilogram
NA = Not available
pCi/g = Picocuries per gram

Groundwater (Waste Rock Seeps)

- Minimize COCs in waste rock leachate to prevent degradation of groundwater underlying Juniper Mine.

- Minimize COCs in waste rock leachate to allow Pit and Red Rock Creeks to meet the following water quality standards or from unacceptably degrading water quality.

Chemical of Concern	Site Background	Unit	Human Health Benchmark	Source	Ecological Benchmark	Unit	Source
Thallium	3.1	μg/L	2	a	1.7	μg/L	c
Total Uranium	87	μg/L	30	a	NA	--	--
Uranium-234	25.6	pCi/L	20	b	NA	--	--
Uranium-238	21.0	pCi/L	20	b	NA	--	--
Radium-226	15.2	pCi/L	5	a	160	pCi/L	d
Lead-210	10.2	pCi/L	1.0	b	NA	--	--

Notes:

a U.S. EPA Region 9 maximum contaminant level (EPA 2004)
b Calculation of Lifetime Cancer Risk of Maximum Contaminant Limits (MCLs) for Radionuclides
c Federal ambient water quality criteria as presented in " A Compilation of Water Quality Goals" (Marshack 2003)
d Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at Oak Ridge National Laboratory, Oak Ridge, Tennessee" (BJC 1998).
μg/L = Micrograms per liter
pCi/L = Picocuries per liter

Pit and Red Rock creeks are fed by groundwater that contains uranium and other radionuclides at concentrations that exceed water quality standards and applicable benchmarks due to natural pre-mining contact of groundwater with the in-place ore body. Treatment of naturally occurring levels of chemicals in groundwater to a more stringent benchmark or standard is not economically feasible and is prohibited under CERCLA 104(a)(3)(A) (see Section 5.2). Therefore, COCs in any leachate generated will be treated to local, naturally-occurring groundwater concentrations if the effluent is discharged to groundwater. However, if the effluent is discharge to surface water, then the COCs must be treated to their respective MCLs. Additional sampling of local groundwater may be desirable to refine the target concentrations of metals and radionuclides.

Surface Water (Pit and Red Rock Creeks)

- Reduce exposure risks for recreational visitors and terrestrial and aquatic biota to the following benchmark or less;
- Minimize COCs in surface water discharging from the mine pit and mine waste to allow Pit and Red Rock creeks to meet the following surface water quality standards or from unacceptably degrading water quality.
- Minimize COCs in sediment discharging from the mine pit and mine waste to allow Pit and Red Rock creeks to meet the following surface water quality standards or from unacceptably degrading water quality.

Chemical of Concern	Site Background	Unit	Human Health Benchmark	Source	Ecological Benchmark	Unit	Source
Total Uranium	87	μg/L	30	a	NA	--	--
Uranium-234	25.6	pCi/L	20	b	NA	--	--
Uranium-238	21	pCi/L	20	b	NA	--	--

Notes:

a U.S. EPA Region 9 maximum contaminant level (EPA 2004)
b Calculation of Lifetime Cancer Risk of Maximum Contaminant Limits (MCLs) for Radionuclides
μg/L = Micrograms per liter
pCi/L = Picocuries per liter

Pit and Red Rock creeks are fed by groundwater that contains uranium and other radionuclides at concentrations that exceed water quality standards and applicable benchmarks due to natural pre-mining contact of groundwater with the in-place ore body. Treatment of naturally occurring levels of chemicals in groundwater to a more stringent benchmark or standard is not economically feasible and is prohibited under CERCLA 104(a)(3)(A) (see Section 5.2). Therefore, COCs in surface water discharging from the mine will be treated to local, naturally-occurring groundwater concentrations if the effluent is discharged

to groundwater. However, if the effluent is discharge to surface water, then the COCs must be treated to their respective MCLs. Additional sampling of local groundwater may be desirable to refine the target concentrations of metals and radionuclides.

Sediment (Pit and Red Rock creeks, Outwash Area)

- Reduce gamma radiation risk (due to Ra-226) to recreational visitors and terrestrial and aquatic biota to below the EPA excess dose limit of 15 mrem/year or 29 μR/hr (background plus 12 μR/hr, assuming a 52 day per year recreational exposure scenario)

- Reduce ingestion risk to recreational visitors and terrestrial and aquatic biota to the following benchmarks or less.

Chemical of Concern	Site Background	Unit	Human Health Benchmark	Source	Ecological Benchmark	Source
Arsenic	4.6	mg/kg	5.21	a	42	c
Thallium	0.94	mg/kg	67	a	NA	--
Uranium	1.4	mg/kg	2,130	a	NA	--
Uranium-235	0.059	pCi/g	3.1	b	3,000	d
Uranium-238	0.87	pCi/g	15	b	2,000	d
Thorium-228	0.75	pCi/g	0.81	b	NA	--
Radium-226	0.72	pCi/g	0.2	b	28,200	e
Lead-210	1.67	pCi/g	11	b	NA	--

Notes:

a Calculated EPA Region 9 Preliminary Remediation Goal using site-specific exposure scenario (EPA 2004)
b Soil Screening Guidance for Radionuclides: User's Guide (EPA 2000)
c Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al 1997)
d A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE 2002)
e Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. (Jones et al 1997)
EPA = U.S. Environmental Protection Agency
mg/kg = Milligrams per kilogram
NA = Not available
NE = Not exceeded
pCi/g = Picocuries per gram

Radon Gas in Air

C Reduce risk due to inhalation of radon gas from the mine pit and mine wastes to the applicable benchmark or less.

Reduction of Ra-226 in soil to the human health benchmark of 0.2 pCi/g will reduce radon emission to levels typically measured in outdoor air. However, if a containment alternative is selected as part of the response action, then a liner should be used to prevent the emission of radon gas and the thickness of the cover should be sufficient to preclude exposure of a recreational visitor to gamma radiation levels greater than 15 mrem/year. A ventilation system would not be required as part of the cover design.

7.0 IDENTIFICATION AND SCREENING OF RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

The selection of the appropriate response action alternative(s) for Juniper Mine will depend on the following: 1) the nature and types of waste and source materials; 2) the waste and source material location; 3) the concentration of uranium and decay products in the waste and source materials, 4) the level of gamma radiation emitted from waste and source materials, 5) the volume of waste and source materials, and 6) the effectiveness of the potentially applicable technology and process options.

The response action alternative selection process involves four steps that include: 1) identification and description of general response actions, technologies, and process options; 2) initial technology screening and alternative development; 3) detailed analysis of alternatives; and 4) comparative analysis of alternatives. The identification and description of general response actions, technologies, and process options are presented in Section 7.1. The results of the initial technology screening and alternative development process for Juniper Mine are described in Section 7.2. The detailed analysis of alternatives is presented in Sections 8.0. The comparative analysis of alternatives and presentation of the recommended site strategy are presented in Section 9.0.

7.1 IDENTIFICATION OF GENERAL RESPONSE ACTION, TECHNOLOGIES, AND PROCESS OPTIONS

The first step in the response action alternative selection process is identifying and describing general response actions that may satisfy the response action objectives. General response actions are then progressively refined into technology types and process options. The process options are then screened in Section 7.2 and the retained technologies and process options are combined into potential response action alternatives. The purpose of the initial screening is to eliminate process options that are not feasible from further consideration and retain those process options that are potentially feasible.

In order to facilitate the identification and screening of potentially applicable response actions, technologies, and process options, six sources of contamination have been identified at Juniper Mine: 1) in place ore within the mine pit, 2) the waste rock piles and outwash areas, 3) waste rock covered roads, 4) sediment in and on the floodplains of Pit Creek and the canyon reach of Red Rock Creek, 5) pit spring and waste rock seeps, and 6) shallow groundwater down gradient of the Waste Rock Pile No.2. General response actions, technologies, and process options potentially capable of meeting the response action objectives for these six sources of contamination are identified in Tables 7-1a and 7-1b for solid

and aqueous media, respectively. Response actions for solid media include no action, institutional controls, engineering controls, excavation and treatment, and in place treatment. Response actions for the pit spring and waste rock seeps, Pit and Red Rock creeks, and shallow groundwater include no action, institutional controls, engineering controls, and treatment. The following paragraphs describe the general response actions, technologies, and process options for solid and aqueous media at Juniper Mine.

7.1.1 No Action

Under the no action option, no response actions would occur at Juniper Mine. The no action response is a stand-alone response that is used as a baseline against which other response action alternatives are compared. The no action alternative will be retained through the detailed analysis of alternatives.

7.1.2 Institutional Controls

CERCLA Section 121(d)(2)(B)(ii)(III) supports the use of institutional controls as part of a response action at CERCLA sites to protect human health and the environment by precluding future access to, or development of, affected sites. The NCP states EPA's preference for treatment to address the principal threats posed by sites; engineering controls for wastes that pose relatively low risk or where treatment is impracticable; and a combination of the two to protect human health and the environment [40 CFR 300.430(a)(1)(iii)(A), (B), and (C)].In addition, institutional controls may be used to protect an implemented remedy.

Institutional controls can be defined as non-engineered measures such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use. Institutional controls are generally to be used in conjunction with, rather than in lieu of, engineering measures such as waste treatment or containment. Some examples of institutional controls include easements, covenants, well drilling prohibitions, zoning restrictions, and special building permit requirements. Potentially applicable institutional controls at Juniper Mine include land use, water use, and access restrictions and are described below.

Land use restrictions

Land use restrictions, comprised of zoning, deed restrictions, or environment control easements would limit potential future uses of the land that could result in unacceptable risks due to human exposure to mine contamination or loss of remedy integrity.

Zoning. Zoning would be implemented to control present and future land uses on or around waste and source areas consistent with the potential hazards present, the nature of response action implemented, and future land-use patterns. The objective of zoning would be to prevent public or private misuse of waste and source areas that could jeopardize the effectiveness of response action taken or pose an unacceptable potential for human exposure to the contaminants present in the waste and source areas.

Deed Restrictions. Restrictions would be used to prevent the transfer of property without notification of limitations on the use of the property or requirements related to preservation and protection of the effectiveness of response action that may have been taken. Both elements are intended to limit the potential for human exposure to waste and source area contamination.

Environmental Control Easements. Environmental control easements are an enforceable easement mechanism for imposing restrictions on the use of a site and requiring performance of operations and maintenance activities that may help protect public health, safety, and welfare and the environment. The easement mechanism is intended to be used at sites that contain or may contain hazardous wastes or substances that may threaten public health, safety or welfare or the environment if certain uses are permitted on these sites or if certain activities are not performed on these sites. Protection of public health, safety, or welfare or the environment may be enhanced by the application and enforcement of certain restrictions on the future use of the site or requirements for performance of certain activities.

Water Use Restrictions

Groundwater in contact with the naturally occurring the ore body in the area around Juniper Mine contains uranium at concentrations above federal MCLs. The occurrence of elevated uranium in groundwater is not associated with mining activity. However, groundwater use restrictions may be necessary to limit potential future uses of groundwater. Surface water use restrictions may also be necessary, to limit potential future uses of surface water that could result in unacceptable risks due to human exposure, as springs emanating from the Juniper Mine contain naturally occurring levels of uranium at concentration above federal MCLs.

Access restrictions

Access restrictions typically include physical barriers, such as fencing, that could prevent both human and wildlife access to Juniper Mine to preclude exposure to site solid and aqueous waste contamination, the open pit, and to protect the integrity of the remedy. Fencing can be installed around the perimeter of waste and source areas to prevent human and animal access to the areas. Posted warnings would identify the potential hazards present at the waste and source areas to deter trespass and misuse. However, fencing at Juniper Mine has not been shown to be able to withstand snow loading and movement, and will require major repair each summer.

Institutional controls could be implemented as a stand-alone remedy, or in combination with other alternatives. USFS, as lead federal agency, or cognizant state agencies would likely enforce institutional controls that are developed as part of an alternative for Juniper Mine. Therefore, these entities must be involved in developing and eventually implementing any institutional controls.

This type of action does not, in itself, achieve a specific cleanup goal. Considering the contaminant concentrations present at Juniper Mine, institutional controls alone are not considered adequate to mitigate potential human health, ecological, and water quality impacts. However, institutional controls will be considered in conjunction with other response action alternatives.

7.1.3 Engineering Controls

Engineering controls are used primarily to reduce the mobility of, and exposure to, contaminants. These goals are accomplished by creating a barrier that prevents direct exposure and transport of waste from the contaminated source to the surrounding media. Engineering controls also provide a barrier to emissions of gamma radiation and radon gas. Engineering controls do not reduce the volume or toxicity of the hazardous material. Engineering controls for solid media typically applied include containment, revegetation, run on and runoff control, and disposal in a repository. These engineering controls are discussed in the following subsections.

7.1.3.1 Surface Controls

Surface control measures are used primarily to reduce contaminant mobility, and limit direct exposure. Surface controls may be appropriate in more remote areas where direct human contact is not a primary

concern (human receptors are not living or working directly on or near the site). Surface control process options include consolidation, grading, erosion control and protection, revegetation, run-on and run-off controls, detention/infiltration basins and traps, and flood control and protection. These process options are usually integrated as a single response action alternative.

Consolidation. Consolidation involves grouping similar waste types in a common area for subsequent management or treatment. Excavation during consolidation is accomplished with standard earthmoving equipment including scrapers, bulldozers, excavators, loaders, and trucks. Consolidation is especially applicable when multiple waste sources are present at a mine and one or more of the sources require removal from particularly sensitive areas (that is, creek bed, flood plain, oversteep slope, slide area, erosive area, or heavy traffic area) or when treating one large combined waste source in a particular location, rather than several smaller waste sources dispersed throughout an area. Precautionary measures, such as stream diversion or isolation, would be necessary during excavation of materials contained in Pit Creek and the canyon reach of Red Rock Creek. Containment and treatment of water encountered during excavation may also be necessary.

Grading. Grading is the general term for techniques used to reshape the ground surface to reduce slopes, manage surface water infiltration and runoff, restore eroded areas, and to aid in erosion control. The spreading and compaction steps used in grading are routine construction practices. The equipment and methods used in grading are similar for all surfaces, but will vary slightly depending on the waste location and the surrounding terrain. Equipment may include bulldozers, scrapers, graders, and compactors. Periodic maintenance and regrading may be necessary to eliminate depressions formed as a result of settlement, subsidence, or erosion.

Erosion control and protection. Erosion control and protection includes using erosion-resistant materials, such as mulch, natural or synthetic fabric mats, gabions, riprap to reduce the erosion potential at the surface of the contaminated medium. The erosion-resistant materials are placed in areas susceptible to surface water erosion (concentrated flow or overland flow) or wind erosion. Proper erosion protection design requires knowledge of drainage area characteristics, average slopes, soil texture, vegetation types and abundance, and precipitation data.

Revegetation. Revegetation involves adding soil amendments to the waste surface to provide nutrients, organic material, and neutralizing agents and improve the water storage capacity of the contaminated media, as necessary. Revegetation will provide an erosion-resistant cover that protects the ground surface

from surface water and wind erosion and reduces net infiltration through the contaminated medium by increasing evapotranspiration processes. In general, revegetation includes the following steps: (1) selecting appropriate plant species, (2) preparing seed bed, which may include deep application of soil amendments to provide acid buffering and enhance vegetation, as necessary, (3) seeding/planting, and (4) mulching and/or chemical fertilizing. Revegetation would likely take place during the fall of the year. A native seed mixture would be used for revegetation due to cold climate, limited growing season, and poor soil conditions. Revegetation of disturbed streams banks and floodplain would also require short term stabilization with erosion control matting and mass planting with native shrubs and trees.

Run-on and Run-off Controls. Run-on controls, including water control bars, berms, and ditches, would be constructed to divert upstream surface water flow around and away from potential waste and source areas. Run-on controls would limit the amount of water entering the waste and source areas to that which falls as precipitation directly on the area. Run-on controls would also prevent direct contact of flowing water in streams or overland flows with the waste and source material. Run-on control construction would be used to reduce the potential for erosion and transport of solid waste and source material away from the area. Run-on controls would also be used to divert surface water flow in order to minimize infiltration into waste and source areas. Run-off controls, including drains and ditches, would be constructed to convey impacted water away from waste and source areas, and any transported sediments to an infiltration basin. Run-off control construction would be used to reduce transport of contaminated materials into nearby creeks and to control leaching and migration of metals from contaminated materials into surface water. Drains would also be used to collect shallow groundwater and leachate generated during rainwater percolation through waste materials.

Detention/Infiltration Basins and Traps. Sediment movement would be controlled through the construction of a detention basin or series of detention basins. Detention basins would serve to retain storm flows while controlling releases at an established flow rate to match the conveyance capacity of the down gradient stream. Detention basins would allow some of the storm-water suspended sediments to settle out of the water. Infiltration basins would serve to retain and isolate surface waters that contact waste and source areas and prevent future migration of sediment. The impounded water would likely be reduced in volume through evaporation and direct infiltration into the subsurface rock mass, although care would have to be taken to minimize infiltration of contaminated water. Infiltration basins would be sized to retain a specific storm event. Sediment traps would most likely be constructed in conjunction with diversion ditches or channels to intercept and retain sediments produced from a source area. These sediment dams or traps could include sediment detention basins constructed within or outside of stream channels where sedimentation would occur.

Flood control and protection. Flood control and protection includes using detention basins, velocity breaks, dry dams, and vegetated flood plains to reduce the erosive force of water during periods of high intensity precipitation and runoff. Contaminant concentrations in and gamma radiation from sediment in and waste rock along Pit Creek and the canyon reach of Red Rock Creek are above human health and ecological screening levels. Therefore, flood control may be required on Pit and Red Rock creeks to prevent erosion of waste rock along the creek and resuspension of potentially contaminated sediment in and immediately below the mine pit. Flood control is not required in the meadow reach of Red Rock Creek as contaminant concentrations in and gamma radiation from sediment were within the risk range for humans and below ecological screening levels. Red Rock Creek is also less susceptible to flash flooding due to a well-vegetated, stable flood plain.

Surface controls are considered a feasible option for all waste and source types at Juniper Mine and will be retained for further consideration as a response action alternative, or in conjunction with other alternatives.

7.1.3.2 Containment

A containment approach leaves waste materials in place and uses an earthen cover or engineered cover to reduce or eliminate exposure to, and mobility of, contaminated medium and emission of gamma radiation and radon gas. Containment source control measures can be used to divert surface water from the contaminated medium and to minimize infiltration (and subsequent formation of leachate) of surface water/precipitation into the underlying contaminated medium. Infiltration can be reduced or prevented by physical barriers (geomembranes) or by increasing evapotranspiration processes. The physical covering of wastes during containment reduces or eliminates the potential health risk that may be associated with exposure (external irradiation or airborne releases of particulates) to the contaminated media.

Cover design may vary in complexity from a simple earthen cover to a multilayered cover designed to meet substantive California requirements. Factors to consider in cover design include physical conditions of the contaminated media, topography, slope stability, leachability, site hydrogeology, precipitation, depth to groundwater, groundwater quality, groundwater use, and applicable groundwater standards. Stringent cover performance standards may not always be appropriate, particularly in instances where the toxicity of the contaminated medium is relatively low, where the cover is intended to be temporary, where

there is very low precipitation, or where the waste is not leached by infiltrating rain water. Specific cover design should also consider the desired land use following cover construction.

Containment is considered a standard construction practice. Equipment and construction methods associated with containment are readily available, and design methods and requirements are well understood. Containment is considered a feasible option for all waste and most source types at Juniper Mine and will be retained for further consideration as a response action alternative or in combination with other alternatives.

7.1.3.3 On-Site Disposal

Permanent, on-site disposal is used as a source control measure and is similar to containment. The objectives of on-site disposal are the same as for containment, except that disposal includes excavation and consolidation of waste into a single, usually smaller area, and may involve installing physical barriers (geomembranes) beneath as well as above the waste. This added barrier may be needed to provide additional protection of groundwater from potential leachate contamination.

On-site disposal options may be applied to treated or untreated contaminated materials. As materials are excavated and moved during this process, treatment may become a cost-effective option. The design configuration of an on-site repository would depend on the toxicity and type of material requiring disposal. The design could range in complexity from an earthen cover to a Group A mine waste repository.

Factors to consider in design include physical condition of the contaminated media, topography, slope stability, leachability, site hydrogeology, precipitation, depth to groundwater, current groundwater quality, area groundwater use, and applicable groundwater standards. Stringent cover performance standards may not always be appropriate, particularly in instances where the toxicity of the contaminated medium is relatively low, where there is very low precipitation, or where the waste is not leached by infiltrating rainwater. Desired land use following cover construction should also be considered in cover design.

Waste rock can be excavated using conventional earth-moving equipment and accepted hazardous materials handling procedures. Steep slopes in the waste rock areas may require use of specialized equipment or construction methods. Precautionary measures, such as stream diversion or isolation, would

be necessary during excavation of materials along Pit Creek and the canyon reach of Red Rock Creek. Containment and treatment of water encountered during excavation and drying of excavated material may also be necessary.

A potential on-site Group A mine waste repository is considered a feasible option for all waste types at Juniper Mine and will be retained for further consideration as a response action alternative or in combination with other alternatives.

7.1.3.4 Off-Site Disposal

Off-site disposal involves placing excavated contaminated material in an engineered waste repository located outside the site boundary. Off-site disposal options may be applied to pretreated or untreated contaminated materials. Materials failing to meet the leachability criteria, if disposed off site, would require disposal in a permitted Class 1 or 2 facility, depending on level of hazard. Conversely, less mobile and less toxic materials could be disposed of in a permitted solid waste landfill in compliance with other applicable laws.

Excavation and disposal at an off-site Class 1 or 2 repository is considered too costly an alternative for wastes at Juniper Mine due to the large volume of waste involved and the high cost for transportation and disposal. In addition, a Class 2 repository would not accept radiological material. The closest Class 1 repository that accepts radiological material is located in Toole, Utah.

7.1.4 Excavation and Treatment

Excavation and treatment incorporate the excavation of mine waste and subsequent treatment through a specific treatment process that chemically, physically, or thermally results in a reduction of contaminant toxicity and volume. Treatment processes have the primary objective of either: (1) concentrating the metal contaminants for additional treatment or recovery of valuable constituents, or (2) reducing the toxicity of the hazardous constituents.

Excavation can be completed using conventional earth-moving equipment and accepted hazardous materials-handling procedures. Precautionary measures, such as stream diversion or isolation, would be necessary during excavation of materials along Pit Creek and the canyon reach of Red Rock Creek. Containment and treatment of water encountered during excavation may also be necessary.

7.1.4.1 Fixation and Stabilization

Fixation and stabilization technologies are used to treat materials by physically encapsulating them in an inert matrix (stabilization) and chemically altering them to reduce the mobility and toxicity of their constituents (fixation). These technologies generally involve mixing materials with binding agents under prescribed conditions to form a stable matrix. Fixation and stabilization are established technologies for treating inorganic contaminants. The technologies incorporate a reagent or combination of reagents to facilitate a chemical and physical reduction of the mobility of contaminants in the solid media. Lime/fly ash-based treatment processes and pozzolan/cement-based treatment processes are potentially applicable fixation and stabilization technologies. Stabilized material must still be disposed of in an on- or off-site facility.

Excavation and subsequent fixation and stabilization treatment are not considered feasible options for Juniper Mine because the technology does not reduce gamma radiation and the large volume of waste present makes the treatment cost prohibitive. Other feasible options can provide equal protectiveness.

7.1.4.2 Reprocessing

Reprocessing involves excavating and transporting the mine waste to an existing permitted mill facility for processing and economic recovery of target metals. Applicability of this option depends on the willingness of an existing permitted facility to accept and process the material and dispose of the waste. Although reprocessing at active facilities has been conducted in the past, permit limitations, CERCLA liability, and process constraints all limit the feasibility of this process option.

Reprocessing is not considered feasible at Juniper Mine due to the low value of recoverable uranium in the majority of the waste material and the high cost of transportation and reprocessing. The closest milling facility is located in Blanding, Utah. Other feasible options can provide equal protectiveness.

7.1.4.3 Physical and Chemical Treatment

Physical treatment processes use physical characteristics to concentrate constituents into a relatively small volume for disposal or further treatment. Chemical treatment processes act through the addition of a chemical reagent that removes or fixes the contaminants. The net result of chemical treatment processes is a reduction of toxicity and mobility of contaminants in the solid media. Chemical treatment processes

often work in conjunction with physical processes to wash the contaminated media with water, acids, bases, or surfactant. Potentially applicable physical/chemical treatment process options include soil washing, acid extraction, and alkaline leaching.

Soil washing. Soil washing is an innovative treatment process that consists of washing the contaminated medium (with water) in a heap, vat, or agitated vessel to dissolve water-soluble contaminants. Soil washing requires that contaminants be readily soluble in water and sized sufficiently small so that dissolution can be achieved in a practical retention time. Dissolved metal constituents contained in the wash solution are precipitated as insoluble compounds, and the treated solids are dewatered before additional treatment or disposal. The precipitates form a sludge that would require additional treatment, such as dewatering or stabilization before disposal.

Acid extraction. Acid extraction applies an acidic solution to the contaminated medium in a heap, vat, or agitated vessel. Depending on temperature, pressure, and acid concentration, varying quantities of the metal constituents present in the contaminated medium would be solubilized. A broader range of contaminants can be expected to be acid soluble at ambient conditions using acid extraction versus soil washing. Dissolved contaminants are subsequently precipitated for additional treatment and disposal.

Alkaline leaching. Alkaline leaching is similar to acid extraction in that a leaching solution (in this case, ammonia, lime, or caustic soda) is applied to the contaminated medium in a heap, vat, or agitated vessel. Alkaline leaching is potentially effective for leaching most metals from the contaminated media; however, the removal of arsenic is not well documented.

Excavation and subsequent physical and chemical treatment are not considered feasible options because the large volume of waste, and relatively low initial contaminant concentration and treatment goal makes treatment cost prohibitive. In addition, the technologies do not completely address gamma radiation remaining in residual contamination. Other feasible options can provide equal protectiveness.

7.1.4.4 Thermal Treatment/Vitrification

Under thermal treatment technologies, heat is applied to the contaminated medium to volatilize and oxidize metals and render them amenable to additional processing and to vitrify the contaminated medium into a glass-like, nontoxic, nonleachable matrix. Potentially applicable moderate-temperature thermal processes, which volatilize metals and form metallic oxide particulates, include the fluidized bed reactor,

the rotary kiln, and the multihearth kiln. Potentially applicable high-temperature thermal treatment processes include vitrification. All components of the contaminated medium are melted and volatilized under high temperature vitrification. Volatile contaminants and gaseous oxides of sulfur are driven off as gases in the process, and the nonvolatile, molten material that contains contaminants is cooled and, in the process, vitrified.

Thermal treatment technologies can be applied to wet or dry contaminated medium; however, the effectiveness may vary somewhat with variable moisture content and particle size. Crushing may be necessary as a pretreatment step, especially for large and variable particle sizes, such as the materials in waste rock piles. Moderate-temperature thermal processes should be considered only as pretreatment for other treatment options. This process concentrates the contaminants into a highly mobile (and potentially more toxic) form. High-temperature thermal processes immobilize most metal contaminants into a vitrified slag that would require proper disposal. The volatile metals would be removed or concentrated into particulate metal oxides, which would likely require disposal as hazardous waste. Thermal treatment costs are extremely high compared to other potentially applicable response action technologies.

Excavation and subsequent thermal treatment are not considered feasible options because of the lack of infrastructure necessary to deliver high voltage electricity to the site, treated waste and byproducts would still require on- or off-site disposal, the technology does not reduce gamma radiation, and the large volume of waste makes treatment cost prohibitive. Other feasible options can provide equal protectiveness.

7.1.5 In-place Treatment

In-place treatment involves treating the contaminated medium where it is currently located. In-place technologies reduce the mobility and toxicity of the contaminated medium and may reduce exposure to the contaminated materials; however, they allow a lesser degree of control, in general, than ex situ treatment options.

7.1.5.1 Physical and Chemical Treatment

Potentially applicable in-place physical and chemical treatment technologies include soil flushing and stabilization/solidification.

Soil flushing. Soil flushing is an innovative process that injects an acidic or basic reagent or chelating agent into the contaminated medium to solubilize metals. The solubilized metals are extracted using established dewatering techniques, and the extracted solution is then treated to recover metals or is disposed of as aqueous waste. Low-permeability materials or stratified waste may hinder proper circulation, flushing solution reaction, and ultimate recovery of the solution. Currently, soil flushing has been demonstrated only at the pilot scale.

Stabilization and solidification. In-place stabilization and solidification are similar to conventional stabilization in that a solidifying agent (or combination of agents) is used to create a chemical or physical change in the mobility and toxicity of the contaminants. The in-place process uses deep-mixing techniques to allow maximum contact of the solidifying agents with the contaminated medium.

In-place physical and chemical treatment is not considered a feasible option because of limited demonstrated success, the technologies do not completely address gamma radiation, and the large volume of waste makes the treatment cost prohibitive. Other feasible options can provide equal or greater protectiveness.

7.1.5.2 Thermal Treatment

In-place vitrification is an innovative process used to melt contaminated solid media in place to immobilize metals into a glass-like, inert, nonleachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid medium to act as a continuous electrical conductor. This technology is seriously inhibited by high moisture content. Gases generated by the process must be collected and treated in an off-gas treatment system. In-place vitrification has been demonstrated only at the pilot scale, and treatment costs are extremely high compared to other treatment technologies.

In-place thermal treatment is not considered a feasible option because of the lack of infrastructure necessary to deliver high voltage electricity to the site, the technology does not reduce gamma radiation, and the large volume of waste makes the treatment cost prohibitive. Other feasible options can provide equal or greater protectiveness.

7.1.6 Treatment of Surface Water and Groundwater

Treatment of surface water, groundwater, or leachate involves specific processes that biologically, physically, or chemically result in a reduction of contaminant toxicity, mobility, and volume. Treatment processes have the primary objective of either: (1) concentrating the metal contaminants for additional treatment or disposal, (2) reducing the mobility of metal contaminants, or (3) reducing the toxicity of the hazardous constituents.

7.1.6.1 Biological Treatment

Treatment of metal-contaminated surface water, groundwater, or leachate could be accomplished with the use of constructed wetlands or anaerobic biocell systems.

Constructed Wetlands. Constructed wetlands are designed to mimic chemical conditions in natural areas such as marshes, bogs, wet meadows, peat lands, and swamps. Constructed wetlands can be designed to remove metals from contaminated water or leachate by the reduction of metals through bacterial sulfate-reduction reactions. Wetlands are particularly effective at dissolved uranium capture due to reduced conditions and high organic carbon content. This artificial environment mimics the natural depositional process of uranium in ore bodies. The metals are removed as a precipitate within the wetlands, or collected in a settling basin. Wetlands can also be used to reduce concentrations of suspended solids in creeks and storm water runoff. Constructed wetlands depend on plant growth to feed the carbon cycle necessary for year round growth. Therefore, constructed wetlands may have limited use at sites with short growing season. Precipitate generated would contain high concentrations of uranium requiring expensive disposal.

Anaerobic Biocells. Biocell systems are anaerobic systems that typically include a layer of organic material (for example, wood chips or manure) that is placed over a drainage layer. Biocell systems are designed to remove metals from contaminated water or leachate by the reduction of metals through bacterial sulfate-reduction reactions. Biocells are particularly effective at dissolved uranium capture due to reduced conditions and high organic carbon content. This artificial environment mimics the natural depositional process of uranium in ore bodies. The biocell system design can include a downflow or upflow configuration, perforated drain lines within a lined pond, and various types of organic layers. The metals are removed as a precipitate within the biocell, or collected in a settling basin. In extremely cold environments with limited winter access, the level of biological activity can be maintained with the

addition of a slow addition carbon substrate (for example, alcohol). Precipitate generated would contain high concentrations of uranium requiring expensive disposal.

7.1.6.2 Physical/Chemical Treatment

Treatment of metal-contaminated surface water, groundwater, or leachate could be accomplished by a variety of physical and chemical treatment processes including coagulation, clarification, filtration, neutralization, oxidation, and precipitation, zero valence iron (ZVI) reactor, reverse osmosis or nano-filtration, adsorption, and ion exchange. In many cases a combination of these processes would be required to achieve the desired level of heavy metal removal from water or leachate.

Coagulation, Clarification, and Filtration. Coagulation, clarification, and filtration are the process steps used in traditional water treatment to remove suspended solids. During coagulation, chemicals are added to the water or leachate to promote the formation of floc, or small particles of suspended solids. Under clarification the heavier of these particles settle out. During filtration the remaining particles are filtered from the water by passing the water through a layer of fine sand. This process is an effective method for removing suspended solids containing metals. The process would not be particularly effective in the removal of dissolved metals. However, the process could be modified to increase the rate of metal removal through the addition of other steps such as neutralization or oxidation. Precipitate generated would contain high concentrations of uranium requiring recycling or expensive disposal.

Neutralization, Oxidation, and Precipitation. Neutralization and/or oxidation followed by precipitation of metal hydroxides are effective methods of reducing dissolved metals. Neutralization and oxidation result in the formation of metal hydroxides which will precipitate in the solution and which can then be removed by gravitational settling or filtration. Neutralization is accomplished through the addition of lime, caustic soda or soda ash. Oxidation is accomplished through aeration or by the addition of chemical oxidants such chlorine or potassium permanganate. After metal removal, it may be necessary to lower the pH of the highly alkaline treated water. Precipitate generated would contain high concentrations of uranium requiring recycling or expensive disposal.

Zero Valence Iron Reactor. Substantial research, pilot, and full-scale efforts have been initiated over the past few years to identify reactive materials that can be used to treat metals found in surface water, groundwater, or leachate. The reactive media most successfully deployed to date has been ZVI. Uranium is present in the +6 oxidation state (UO_2^{2+}) at Juniper Mine and occurs as a $UO_2(CO_3)_2^{-2}$ complex in the

presence of bicarbonate. ZVI has been shown to be highly effective in removing inorganic contaminants (UO_2^{2+}, MoO_4^{2-}, TcO_4^-, and CrO_4^{2-}) from aqueous solution. The removal mechanism appears to be reductive precipitation. The reaction between uranium (VI) and iron (0) can be expressed as:

$$Fe^0 + UO_2^{2+}{}_{(aq)} \rightarrow Fe^{2+} + UO_{2\,(s)}$$

where urananite $UO_{2\,(s)}$ is an amorphous or crystalline uranium oxide precipitate. The process involves gravity feeding surface water, groundwater, or leachate through a bed of ZVI, allowing sufficient time for the precipitation of urananite on the ZVI. This mechanism is similar to the organic carbon induced reduction and precipitation of uranium in the original ore deposit. The spent iron would contain high concentrations of uranium requiring recycling or expensive disposal.

Reverse Osmosis and Nano-Filtration. Reverse osmosis and nano-filtration are physical and chemical processes in which hydraulic pressure is used to reverse the osmosis process by forcing water or leachate from a concentrated solution through a semipermeable membrane into a dilute solution. Dissolved metals are retained in the concentrated solution, known as reject. Reverse osmosis and nano-filtration are effective methods of removing dissolved metals from water or leachate. Reverse osmosis and nano-filtration do, however, require a substantial investment in energy to generate the hydraulic pressures required to reverse the osmosis process. In addition the reject solution would contain high concentrations of uranium requiring recycling or expensive disposal. Point-of-use reverse osmosis units can be used for treatment of groundwater at individual households to remove metals.

Adsorption and Ion Exchange. Adsorption is the process in which material dissolved in water or leachate accumulates on the surface of solids brought into contact with the water. The rate of removal is a function of the surface area of the solids, so materials with a large surface area in proportion to the volume of solid tend to be highly sorbent. Perhaps the best example of this type of material is activated carbon. Adsorption has been shown to be effective methods of removing dissolved metals. The adsorption material must be periodically replaced or regenerated. The spent adsorption material may contain high concentrations of uranium, which may require expensive disposal.

Ion exchange is the process in which ions held by electrostatic forces to a surface of a solid are exchanged for ions of similar charge in a solution in which the solid (resin) is immersed. As solution flows through a resin bed, ion exchange occurs. Selective ion exchange uses specially selected resins to remove or reduce specific contaminants (e.g. uranium) from water. Selective ion resins are unaffected by other

dissolved solids in the feed stream. The exchange resin must be periodically replaced or regenerated. The spent resin would contain high concentrations of uranium, which would require regeneration at an off-site facility and recovery of uranium from the elutent at an off-site milling facility.

Discharge of Treatment System Effluent to Surface Water and Groundwater. Treatment system effluent may be discharged directly to surface water or to groundwater. Effluent discharged to surface water would occur as an end of pipe discharge directly to Pit Creek, provided federal MCLs are obtained. Discharge to groundwater would occur as either subsurface percolation or direction infiltration into a series or gallery of wells.

Subsurface percolation involves the gravity drainage of effluent from a treatment system to the percolation area and division of the flow into multiple perforated pipes set in gravel filled trenches. The objective is to spread the effluent as evenly as possible over the required land area, minimizing the possibility of the ground becoming over-saturated. A percolation test is necessary to determine the rate of infiltration and total length and depth of gravel filled trenching required for a given discharge rate.

Infiltration of treatment system effluent involves the construction and screening of multiple wells within the vadose zone and first water bearing zone, hydrofracturing of the formation to improve the infiltration rate as necessary, and the gravity drainage of effluent from a treatment system into each well. Valving may be required to ensure an even distribution of effluent to each infiltration well. Infiltration wells are typically greater than 6 inches in diameter to increase the surface are available for infiltration.

Hydrofracturing is accomplished by lowering a borehole packer into a well and expanding it below the casing depth/static level and above the fracture/joint system. This isolates the potential production zone from the rest of the well. Water is then pumped down through a water injection pipe at high-pressure and high-volume simultaneously. The pressure and flow created in the production zone usually causes small, tight fractures/joints in the rock to open up and spread radially. The newly opened and flushed out fractures provide connections between nearby water-bearing fractures and the borehole. Hydrofracturing has been shown to increase production rates between 70 and 95 percent, depending on geology.

7.2 TECHNOLOGY SCREENING SUMMARY AND DEVELOPMENT OF RESPONSE ACTION ALTERNATIVES

After identifying potential response action technologies and process options, the technologies and process options are subjected to initial screening, which is the second step in the response action alternative development process. The purpose of technology and process option screening is to evaluate the identified options based on the NCP criteria of effectiveness, implementability, and relative costs, and eliminate technologies and process options to reduce the number of alternatives developed and carried forward for detailed analysis. A technology or process option can be eliminated from further consideration if they do not meet the effectiveness or implementability criteria. Also, a technology or process option can be eliminated if its cost is substantially higher than other technologies or process options, and at least one other technology or process option is retained that offers equal protectiveness. This second level of technology and process option screening is effective as a method of reducing the number of alternatives developed for subsequent detailed analysis. A summary of the initial screening of response actions, technologies, and process options for solid and aqueous media are provided in Tables 7-2a and 7-2b, respectively.

The response actions, technologies, and process options that were retained have been combined into the response action alternatives shown in Table 7-3. Response action alternatives were divided between solids and water to allow flexibility in applying water treatment technologies to the different solids handling alternatives. Because the number of alternatives is not unreasonably high, and since none of these alternatives could obviously be eliminated through an additional screening step, all of these alternatives will be carried through to the detailed analysis in Section 8.0.

TABLE 7-1a

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR SOLID MEDIA AT JUNIPER MINE

General Response Action	Technology Type	Process Options
No Action	None	None
Institutional Controls	Access Restrictions	Fencing/Barrier
		Land Use Control
Engineering Controls	Surface Controls	Consolidation
		Grading
		Revegetation
		Erosion and Flood Control
	Containment	Earthen Cover
		Earthen Cover with Geomembrane Liner
	On-Site Disposal	Earthen Cover
		Earthen Cover with Geomembrane Liner
		Group A Mine Waste Repository
		Underground Disposal
	Off-Site Disposal	Solid Waste Landfill
		Class 2 Repository
		Class 1 Repository
Excavation and Treatment	Fixation/Stabilization	Cement/Silicates
	Reprocessing	Milling/Smelting
	Physical/Chemical Treatment	Soil Washing
		Acid Extraction
		Alkaline Leaching
	Thermal Treatment	Rotary Kiln
		Vitrification
In-Place Treatment	Physical/Chemical Treatment	Soil Flushing
		Solidification/ Stabilization
	Thermal Treatment	Vitrification

TABLE 7-1b

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR AQUEOUS MEDIA AT JUNIPER MINE

General Response Action	Technology Type	Process Options
No Action	None	None
Institutional Controls	Access Restrictions	Fencing/Barrier
		Land Use Control
		Water Use Control
Engineering Controls	Surface and Subsurface Controls	In Stream Catch Basin
		Surface/Subsurface Diversion
Treatment	Biological Treatment	Constructed Wetland
		Anaerobic Biocell
	Physical/Chemical Treatment	Coagulation, Clarification, and Filtration
		Neutralization, Oxidation, Precipitation
		Zero Valence Iron Reactor
		Reverse Osmosis/ Nano-Filtration
		Adsorption
		Ion Exchange

TABLE 7-2a
RESPONSE ACTION TECHNOLOGY SCREENING COMMENTS SUMMARY
FOR SOLID MEDIA AT JUNIPER MINE
(Page 1 of 3)

General Response Actions	Response Action Technology	Process Options	Description	Screening Comment
No Action	None	Not applicable	No action	Not applicable
Institutional Controls	Access Restrictions	Fencing/Barrier	Install fences around waste rock piles and mine pit to limit access.	Potentially effective in conjunction with other technologies; however, will require annual repair due to snow load and movement which damage the fence each winter.
		Land Use Control	Implement restrictions to control current and future land use.	Potentially effective in conjunction with other technologies; readily implementable.
Engineering Controls	Surface Controls	Consolidation, Grading, Revegetation, Erosion Protection, Flood Protection	Combine similar waste types in a common area; level out waste piles to reduce slopes for managing surface water infiltration, runoff, and erosion; manage flood flows to reduce the erosive force of water; add amendments and seed with appropriate vegetative species to establish an erosion-resistant ground surface.	Potentially effective in conjunction with other process options assuming waste does not contain high concentrations of phytotoxic chemicals; limits direct exposure; readily implementable.
	Containment	Earthen Cover	Apply inert waste rock, overburden, or soil and establish vegetative cover to stabilize surface; waste materials are left in place.	Surface infiltration and runoff potential would be reduced, but not prevented; limits direct exposure; readily implementable.
		Earthen Cover with Geomembrane Liner	Install geomembrane liner with waste rock, overburden, or soil cover over surface; waste materials are left in place.	Surface infiltration and runoff potential would be significantly reduced or eliminated; limits direct exposure; readily implementable.
	On-Site Disposal	Earthen Cover	Excavate waste rock and consolidate on site in the mine pit or on top of another waste rock pile; apply inert waste rock, overburden, or soil and establish vegetative cover to stabilize surface	Exposure would be reduced; surface infiltration and runoff potential would be reduced, but not prevented; limits direct exposure; readily implementable.
		Earthen Cover with Geomembrane Liner	Excavate waste rock and consolidate on site in the mine pit or on top of another waste rock pile; install geomembrane liner with waste rock, overburden, or soil cover over surface.	Exposure would be reduced; surface infiltration and runoff potential would be significantly reduced or eliminated; limits direct exposure; readily implementable.
		Group A Mine Waste Repository	Excavate waste rock and consolidate on site in a Group A mine waste repository within the mine pit.	Surface infiltration and runoff potential would be significantly reduced or eliminated; limits direct exposure; readily implementable.
	Off-Site Disposal	Class 2 Repository	Excavate waste materials and deposit off site in a constructed Class 2 Repository.	Not effective for radiological materials; not implementable as radiological waste is not accepted.

Note: Eliminated alternatives are shaded.

TABLE 7-2a
RESPONSE ACTION TECHNOLOGY SCREENING COMMENTS SUMMARY
FOR SOLID MEDIA AT JUNIPER MINE
(Page 2 of 3)

General Response Actions	Response Action Technology	Process Options	Description	Screening Comment
Engineering Controls (Continued)	Off-Site Disposal (Continued)	Solid Waste Landfill	Excavate and dispose of nonhazardous solid wastes permanently in a state regulated solid waste landfill.	Not effective for radiological materials; not implementable.
		Class 1 Repository	Excavate and dispose of wastes permanently in a Class 1 Repository.	Potentially effective, and readily implementable; transport and disposal cost would be prohibitive.
Excavation And Treatment	Fixation/ Stabilization	Cement/Silicates	Incorporate hazardous constituents into non-leachable cement or pozzolan solidifying agents.	Extensive treatability testing required; proper disposal of stabilized product would be required; potentially implementable, but cost-prohibitive.
	Reprocessing	Milling	Ship wastes to existing milling facility for economic extraction of metals.	Not economically feasible at average waste rock concentrations.
	Physical/ Chemical Treatment	Soil Washing	Separate hazardous constituents from solid media via dissolution and subsequent precipitation.	Effectiveness is questionable; potential exists to increase mobility by providing partial dissolution of contaminants; more difficulty encountered with wider range of contaminants.
		Acid Extraction	Mobilize hazardous constituents via acid leaching and recover by subsequent precipitation.	Effectiveness is questionable; potential exists to increase mobility by providing partial dissolution of contaminants; effectiveness is not well documented for uranium.
	Physical/ Chemical Treatment	Alkaline Leaching	Use alkaline solution to leach contaminants from solid media in a heap, vat, or agitated vessel.	Effectiveness is questionable; potential exists to increase mobility by providing partial dissolution of contaminants; effectiveness is not well documented for uranium.
	Thermal Treatment	Fluidized Bed Reactor/Rotary or Multihearth Kiln	Concentrate hazardous constituents into a small volume by volatilization of metals and formation of metallic oxides as particulates.	Further treatment is required to treat process by-products; potentially implementable, but cost prohibitive.
		Vitrification	Use extremely high temperature to melt and/or volatilize all components of the solid media; the molten material is cooled and, in the process, vitrified into a nonleachable form.	Further treatment is required to treat process by-products; not implementable due to remoteness of site (no electrical infrastructure); cost prohibitive.
In-Place Treatment	Physical/ Chemical Treatment	Stabilization	Stabilize waste constituents in place when combined with injected stabilizing agents.	Extensive treatability testing required; potentially implementable, but cost prohibitive.
		Solidification	Use solidifying agents in conjunction with deep soil mixing techniques to facilitate a physical or chemical change in mobility of the contaminants.	Extensive treatability testing required; potentially implementable, but cost prohibitive.

Note: Eliminated alternatives are shaded.

TABLE 7-2a
RESPONSE ACTION TECHNOLOGY SCREENING COMMENTS SUMMARY
FOR SOLID MEDIA AT JUNIPER MINE

General Response Actions	Response Action Technology	Process Options	Description	Screening Comment
In-Place Treatment (Continued)	Physical/ Chemical Treatment (Continued)	Soil Flushing	Acid/base reagent or chelating agent injected into solid media to solubilize metals; solubilized reagents are subsequently extracted using dewatering techniques.	Effectiveness not certain; potential exists to increase mobility by providing partial dissolution of contaminants; innovative process currently in its pilot stage.
	Thermal Treatment	Vitrification	Subject contaminated solid media to extremely high temperature in place; during cooling, material is vitrified into non-leachable form.	Difficulties may be encountered in establishing adequate control; not implementable due to remoteness of site (no electrical infrastructure); cost prohibitive.

Note: Eliminated alternatives are shaded.

TABLE 7-2b
RESPONSE ACTION TECHNOLOGY SCREENING COMMENTS SUMMARY
FOR AQUEOUS MEDIA AT JUNIPER MINE
(Page 1 of 2)

General Response Actions	Response Action Technology	Process Options	Description	Screening Comment
No Action	None	Not applicable	No action	Not applicable
Institutional Controls	Access Restrictions	Fencing/Barrier	Install fences around waste rock piles (seeps) and mine pit (springs and creek) to limit access.	Potentially effective in conjunction with other technologies; however, will require annual repair due to snow load and movement which damage the fence each winter.
		Land Use Control	Implement restrictions to control current and future land use.	Potentially effective in conjunction with other technologies; readily implementable.
		Water Use Control	Implement restrictions to control current and future water use.	Effective for on- and off-site waters; readily implementable.
Engineering Controls	Surface and Subsurface Controls	Detention/Infiltration Basin	Install detention basin within the mine pit.	Effective for capturing mine waste and reducing downstream entrainment of mine waste; promotes a steady discharge necessary for water treatment processes. Very effective in conjunction with other technologies. Readily implementable.
		Surface and Subsurface Diversions	Install surface drains to capture and divert run-on/run-off. Install underdrains to intercept groundwater (reduce waste contact) and seepage (infiltration through waste rock).	Effective for reducing stormwater run-on to mine waste and pit; directing mine waste and pit impacted water for settling or treatment; reducing generation of leachate associated with groundwater flow through mine waste; and for capture of leachate for treatment. Very effective in conjunction with other technologies. Readily implementable.
Treatment	Biological Treatment	Constructed Wetland	Concentrates uranium on organic material and reduced metal surfaces.	Process moderately effective at metals removal. Process is passive, gravity fed, does not rely on a constant flow, and is able to operate for extended periods without maintenance. However, process is not implementable in frigid, short growth seasons due to the need for sufficient growth to sustain winter carbon needs.
		Anaerobic Biocell	Concentrates uranium on organic material and reduced metal surfaces.	Process moderately effective at metals removal. Process is passive, gravity fed, does not rely on a constant flow, and is able to operate for extended periods without maintenance. Process is implementable in frigid conditions as long as flow is maintained. Winter site access is required replenishment of carbon source.
	Physical/Chemical Treatment	Coagulation, Clarification, and Filtration	Concentrate metals in floc after coagulent addition, metal floc settles out or is separated using a fine sand filter.	Process moderately effective at metals removal, given dosage variability required to address changing influent chemistry and flow. However, process is not implementable due to lack of electrical infrastructure, frigid conditions, and winter site access limitations for required regular maintenance.

Note: Eliminated alternatives are shaded.

TABLE 7-2b
RESPONSE ACTION TECHNOLOGY SCREENING COMMENTS SUMMARY
FOR AQUEOUS MEDIA AT JUNIPER MINE
(Page 2 of 2)

General Response Actions	Response Action Technology	Process Options	Description	Screening Comment
Treatment	Physical/Chemical Treatment	Neutralization, Oxidation, Precipitation	Dissolved metals are neutralized or oxidized causing formation of metal precipitate, precipitate settles out or is separated using a fine sand filter.	Process moderately effective at metals removal, given pH dependency of precipitation. However, process is not implementable due to lack of electrical infrastructure, frigid conditions, and winter site access limitations for required regular maintenance.
		Zero Valence Iron Reactor	Concentrates uranium on reduced iron surfaces.	Process very effective at metals removal. Process is passive, gravity fed, does not rely on a constant flow, and is able to operate for extended periods without maintenance. Process is implementable in frigid conditions, as it is located below grade.
		Reverse Osmosis/ Nano-Filtration	Uses hydraulic pressure to force water from a concentrated solution through a semipermeable membrane into a dilute solution. Dissolved metals are retained in the concentrated solution.	Process very effective at metals removal. However, process is not implementable due to lack of electrical infrastructure, frigid conditions, and winter site access limitations for required regular maintenance.
		Adsorption	Concentrates uranium on carbon surfaces.	Process very effective at metals removal; however, regeneration of carbon may be technically difficult due to process handling of radiological materials. In addition, long-term disposal of carbon may be cost prohibitive due to radiological content. Process is implementable in frigid conditions when tanks and feed piping are located below grade. Readily implementable.
		Ion Exchange	Concentrates uranium and other metals on exchange resins.	Process very effective at metals removal. Process is passive, gravity fed, does not rely on a constant flow, and is able to operate for extended periods without maintenance. Process is implementable in frigid conditions when tanks and feed piping are located below grade. Readily implementable.

Note: Eliminated alternatives are shaded.

TABLE 7-3
RESPONSE ACTION ALTERNATIVE SUMMARY
FOR THE JUNIPER MINE
(Page 1 of 1)

Waste or Source Type	Alternative Number	Alternative Description
All wastes and sources	Alternative 1	No action
All wastes and sources	Alternative 2	Institutional controls
All wastes and sources	Alternative 3	Surface and institutional controls, water treatment
Waste rock, waste rock covered roads, sediment in creeks	Alternative 4	Waste rock and sediment consolidation, water treatment, surface and institutional controls
Waste rock, waste rock covered roads, sediment in creeks	Alternative 5	Waste rock and sediment consolidation, earthen cover with geomembrane liner, slurry wall, surface and institutional controls
Waste rock, waste rock covered roads, sediment in creeks, ore body	Alternative 6	Waste rock and sediment consolidation in an engineered Group A mine waste repository within the pit; surface and institutional controls
Pit spring, creeks, waste rock seeps, leachate	Alternative 7	Metals removal from surface water, groundwater, or leachate using zero valence iron
Pit spring, creeks, waste rock seeps, leachate	Alternative 8	Metals removal from surface water, groundwater, or leachate using ion exchange

8.0 DETAILED ANALYSIS OF RESPONSE ACTION ALTERNATIVES

The third step in the response action alternative selection process for Juniper Mine is the detailed analysis. The purpose of the detailed analysis is to evaluate response action alternatives for their effectiveness, implementability, and cost in order to control and reduce toxicity, mobility, and volume of mine wastes at Juniper Mine. The response action alternatives that were retained after the technology and process option identification and screening processes performed in Section 7.0 are included in the detailed analysis.

As suggested in "Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA" (EPA 1993), response action alternatives that were retained after the technology and process option identification and screening processes will be evaluated individually against the following three broad criteria: effectiveness, implementability, and cost. Descriptions of the qualitative evaluation criteria are provided in the following paragraphs.

Effectiveness Evaluation

During an evaluation of the effectiveness of a response action alternative, the ability of the process to protect human health and the environment is reviewed (EPA 1993). Protection is achieved by reducing the toxicity, mobility, and/or volume of the contaminated waste over a short-term and long-term time frame while complying with ARARs.

Effectiveness relates to the potential of an alternative to achieve the response action objectives considering the chemical and physical characteristics of the source and the site conditions. Potential impacts to human health and the environment during the construction and implementation phase as well as the reliability of the process with respect to the site conditions are also considered. For the purposes of this evaluation, effectiveness is considered as low, moderate, high, or uncertain.

Implementability Evaluation

During an evaluation of the implementability of a response action alternative, the technical and administrative feasibility of constructing, operating, and maintaining the alternative is measured (EPA 1993). Technical feasibility takes into account whether or not the response action alternative is applicable to the site and can be properly constructed and operated at the site. The evaluation considers long-term operation, maintenance, and monitoring of the implemented alternative. Administrative feasibility considers regulatory approval and scheduling restraints, as well as the availability of disposal

services, disposal locations, and the necessary construction expertise and equipment. Cognizant state agency and community acceptance are additional criteria that will be considered in the action memorandum after the state and public review the evaluation process and recommended response action alternative. For the purposes of this evaluation, implementability is considered as easy, moderately difficult, or difficult.

Cost Evaluation

The types of costs that will be assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual operation and maintenance (O&M) costs, including long term effectiveness monitoring cost
- Net present worth of capital, O&M costs, and periodic costs.

The present worth of each response action alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the response action at a given rate, would provide the funds required to make future payments to cover all costs associated with the response action over its planned life.

The present worth analysis will be performed on all response action alternatives using a seven percent discount (interest) rate over a period of 5 years and 30 years. Inflation and depreciation were not considered in preparing the present worth costs. Assumptions used in preparing the cost estimates are provided in Appendix A.

The final step of this analysis is to conduct a comparative analysis of the response action alternatives. The comparative analysis, presented in Section 9.0, will discuss each alternative's relative strengths and weaknesses with respect to each of the criteria, and how reasonably key uncertainties could change expectations of their relative performance. Once completed, the findings of the comparative analysis will be used to identify preferred response action alternative(s).

8.1 ALTERNATIVE 1: NO ACTION

Under the no action alternative, no response actions would occur at Juniper Mine. Consequently, potential human health, ecological, and water quality impacts associated with mine contamination are

assumed to remain unchanged. The no action response is a stand-alone response that is used as a baseline against which other response action alternatives are compared. The no action alternative is applicable to all media at Juniper Mine. The no action alternative will be retained through the detailed analysis of alternatives.

8.1.1 Effectiveness

The no action alternative is considered to have low effectiveness for achieving PRAOs. This alternative would provide no control of exposure to the contaminated materials and no reduction in risk to human health or the environment. Gamma radiation and contaminant migration to air, groundwater, surface water, and sediment would be unchanged. Protection of human health would not be achieved under the no action alternative. Prevention of direct human exposure through the pathways of concern would not be achieved. Ingestion, external irradiation, and inhalation of radon gas, soil, and sediment containing radionuclides and metals would not be reduced. Protection of the environment would also not be achieved under the no action alternative. Risks due to ecological exposures through all scenarios would remain unchanged.

A comprehensive list of federal and state ARARs for Juniper Mine is presented in Section 5.0. ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Under the no action alternative, no contaminated materials would be treated, removed, or actively managed. Consequently, no ARARs apply to the no action alternative.

Under the no action alternative, no controls or long-term measures would be placed on the contaminated materials at the site; consequently, this alternative provides no long-term effectiveness. Therefore, the no action alternative would not be effective at minimizing risks from exposure to site wastes. The no action alternative would provide no reduction in toxicity, mobility, or volume of the contaminated materials. In the short-term, the no action alternative would pose no additional threats to the community or the environment than exist under the current site conditions.

8.1.2 Implementability

The no action alternative would be readily implementable and administratively feasible. No permits would be required to implement this alternative. No services or materials would be needed for the implementation of the no action alternative.

8.1.3 Costs

There are no foreseen costs associated with the no action alternative.

8.2 ALTERNATIVE 2: INSTITUTIONAL CONTROLS

Institutional controls can be used to protect human health and the environment by precluding future access to, or development of, affected areas. In addition, these restrictions may be used to protect an implemented remedy. Potentially applicable institutional controls at Juniper Mine consist of land use, water use, and access restrictions. An overview of institutional controls is presented in Section 7.1.2.

Land use restrictions, comprised of zoning, deed restrictions, or environment control easements would limit potential future uses of the land that could result in unacceptable risks due to human exposure to mine contamination or loss of remedy integrity. Because USFS currently owns, maintains, and controls access to the site, no land use restrictions are required.

Water use restrictions would limit potential future uses of surface water and groundwater that could result in unacceptable risks due to human exposure to mine related surface water or groundwater contamination. Groundwater in contact with the naturally occurring ore body in the area contains uranium at concentrations above federal MCLs. The occurrence of elevated uranium in groundwater is not associated with mining activity. However, groundwater use restrictions by the RWQCB may be necessary to limit potential uses of groundwater not impacted by mining activity. Surface water use restrictions by the RWQCB may also be necessary, to limit potential future uses of surface water that could result in unacceptable risks due to human exposure, as springs emanating from area groundwater contain naturally occurring levels of uranium at concentration above federal MCLs. Environmental conditions in the vicinity of the ore body suggest that surface water use restrictions may be necessary up to 1 mile downstream of the ore body and that groundwater use restrictions may be necessary within 0.5 mile of the ore body.

Surface and ground water use restrictions by the USFS may also be necessary as part of a response action, in the absence of or in addition to treatment of mine related contamination, to limit potential future uses of surface water and groundwater. Use restrictions would be limited to surface water and groundwater impacted by mine related activities, that is, metals and radionuclide concentrations above federal MCLs or background concentrations in close proximity to the ore body.

Access restrictions typically include administrative barriers (area and road closures) and physical barriers (fencing and signage) that could prevent both human and wildlife access to Juniper Mine to preclude exposure to site solid and aqueous waste contamination, the open pit, and to protect the integrity of a remedy. USFS has already implemented the substantive portion of this response action alternative as a TCRA in 2003. The TCRA involved construction of a fence around the perimeter of the site to limit site access, installation of signage warning the public about the presence of a radiation hazard, and closure of access roads and the land at and around the mine. The mine access road was closed under Order No. 2003-1 on June 10, 2003 and the area was closed under Order No. 2003-16 on October 7, 2003.

This alternative would involve 1) maintaining the approximately 6,600 feet of 5-foot-tall, five-strand barbed wire fence currently erected around the mine site perimeter, and 2) developing and enforcing surface water and groundwater use restrictions in the absence of or in addition to treatment of mine related contamination. The fencing was installed, as a part of the TCRA, to provide physical barrier to unauthorized site access. One gate has been installed on each end of the Forest Road 5N33 to allow access for authorized personnel. Approximately 33 signs have been posted around the fenced perimeter to warn unauthorized personnel that the area may be hazardous and to identify the potential hazards present to deter trespass and misuse. Extensive repair of fencing will be required each summer, due to snow load damage, to ensure long-term permanence of this remedy. Development and enforcement of water use restrictions would be required where water quality has been impacted by mine related activity and engineering controls cannot attain federal MCLs or background water quality in close proximity to the ore body.

Institutional controls could be implemented as a stand-alone remedy, or in combination with other alternatives. USFS, as lead federal agency, or cognizant state agencies would likely enforce institutional controls that are developed as part of an alternative for Juniper Mine. Therefore, these entities must be involved in developing and eventually implementing any institutional controls.

8.2.1 Effectiveness

This alternative would provide some protection of human health and the environment by limiting access to waste areas, reducing exposure of humans to gamma radiation, and reducing human exposure to impacted surface water and/or groundwater through both administrative and physical controls. This alternative is not fully protective of human health and the environment since surface water, sediment,

groundwater, and air (radon gas and dust) remain potential exposure pathways for contaminants. Because this alternative would provide limited effectiveness for most ecological receptors and would not inhibit any ongoing contaminant migration, the alternative is considered to have low overall effectiveness for achieving response action objectives.

Application of institutional controls at Juniper Mine do not address federal or state contaminant-specific ARARs. Leaching and release of contaminants to groundwater and surface water would not be reduced under this alternative and exceedence of background metals concentrations in groundwater and surface water would remain unchanged. Location-specific ARARs are expected to be met without any conflicts. There are no action-specific ARARs that are required for applying institutional controls at Juniper Mine.

Under the institutional controls alternative, fencing and signage would have to be maintained to ensure it continues to perform as designed; consequently, long-term inspection and maintenance would be required. The long-term effectiveness of the fence would be enhanced by strengthening, during seasonal maintenance, to improve stability under snow loads. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the maintenance activities.

Waste toxicity, mobility, and volume are not reduced under the institutional controls alternative. Short-term risks of exposure to contaminated material, radon gas, and gamma radiation would be a potential for the site worker during fencing repair. Therefore, on-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.

8.2.2 Implementability

Institutional controls such as fencing have been implemented within one field season; however, institutional controls such as water use restrictions would be more difficult to implement given the mobility of surface and ground waters and the lack of enforceability in a remote recreational environment. Equipment, materials, and labor for fencing would be available through the local market. Undertaking additional response action, if necessary, could be achieved after removing the fence and gates. As stated above, institutional controls would not be reliable without proper maintenance.

8.2.3 Costs

The total present worth cost for Alternative 2, institutional controls, is estimated to be $181,822 and $478,033 assuming either 5 or 30 years of maintenance, respectively. The cost for the additional 25 years of maintenance from years 6 through 30 is $296,211. Table 8-1 presents the costs associated with implementing this alternative. Assumptions used in preparing the cost estimate are provided in Appendix A. The total present worth cost includes the present value of 5 and 30 years of annual maintenance costs. There are no capital costs for this alternative as the fencing and signage are already in place. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

8.3 ALTERNATIVE 3: SURFACE AND INSTITUTIONAL CONTROLS, WATER TREATMENT

Surface controls in combination with institutional controls are used primarily to reduce contaminant mobility and limit direct exposure to contaminants. Surface controls may be appropriate in more remote areas where direct human contact is not a primary concern (human receptors are not living or working directly on or near the site). Surface controls are considered a feasible alternative for the mine pit, waste rock piles, and waste rock covered roads. Surface control process options include consolidation, grading, erosion control and protection, revegetation, run-on and run-off controls, detention/infiltration basins and traps, and flood control and protection. An overview of each process option is presented in Section 7.1.3.1. Institutional controls limit direct exposure through the application of water use and access restrictions (see Alternative 2). Waste- and source-specific process options are described below.

Under this alternative, metals in water from the drains at the toes of Waste Rock Pile No.1 and No.2, would require treatment prior to discharge to Pit Creek. In addition surface water from Pit Creek may also require treatment if surface controls are not effective in reducing contaminant migration. Treatment of leachate and potentially surface water would be conducted using either ZVI (Alternative 7) or ion exchange resin (Alternative 8).

Surface controls in the mine pit include:

- Installation of interceptor berm and ditch on upslope side of mine pit high walls to control water running into pit. Route run on, through drainage pipes, to sediment detention basins prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Broadcast fertilizer and seed on to lower slopes and floor of mine pit to create a vegetative filter for sediment capture and reduce erosion.

- Installation of velocity breaks on pit floor to reduce storm water runoff rate and allow longer settling time in an existing sediment detention basin.

- Route Pit Creek discharge from the mine pit through a culvert to Pit Creek below Waste Rock Pile No.2. Isolation of Pit Creek will reduce erosion of Waste Rock Pile No. 2.

- If surface controls are not successful at removing COCs from water discharging from the pit, then treat Pit Creek discharge from the existing sediment detention basin using one of the treatment systems described in Alternatives 7 and 8.

- Spring runoff and late summer baseflow monitoring of Pit Creek for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Yearly clean out of the sediment detention basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and pit floor yearly until vegetation established or lack of viability demonstrated.

Surface controls for the three waste rock piles include:

- Grading of the surface of each waste rock pile to direct runoff away from oversteep slopes. Stabilize toe of slopes and fill large eroded gullies along slopes of waste rock piles.

- Assume radiological screening and air monitoring for 3 weeks during grading activities.

- Scarify, fertilize, and seed surface and slopes of each waste rock pile. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of each waste rock pile to control water running on to the waste rock pile. Route run on, via drainage pipe, to sediment detention basins prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Installation of a sediment detention basin on lowest point of each waste rock pile to capture sediment and control rate of runoff. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Installation of a drain at toe of Waste Rock Pile Nos. 1 and 2 to capture any leachate generated by infiltrating precipitation. Leachate would be discharged for treatment using one of the technologies described in Alternatives 7 and 8.

- Spring and late summer monitoring of leachate from the toe drains for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- After Pit Creek is routed through a culvert, buttress toe of Waste Rock Pile No.2 slope with gabions and regrade to reduce slope.

- Yearly clean out of basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and sediment detention basins yearly until vegetation established or lack of viability demonstrated.

Surface controls for the waste rock covered road include:

- Excavation and grading of waste rock covered roads and consolidation of the waste on top of Waste Rock Pile No. 2. Grade waste on surface of Waste Rock Pile No.2.

- Installation of water control bars along the regraded road to slow run off and route storm water away from the waste rock piles.

- Installation of velocity breaks every 100 feet in the existing unlined drainage ditch along the regraded road.

- Installation of a sediment detention basin at the end of the drainage ditch to capture any mine-related sediment before water discharges from the mine site. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Installation of one 18-inch culvert to divert runoff from between Waste Rock Pile Nos. 1 and 2 under Forest Road 5N33.

- Yearly clean out of basins to remove sediment. Repair water control bars and ditches as necessary. Fertilize and reseed sediment detention basin yearly until vegetation established or lack of viability demonstrated.

8.3.1 Effectiveness

The implementation of this alternative would provide an additional level of protection beyond that provided by institutional controls (Alternative 2) by reducing the mobility of waste and subsequent human and ecological exposure to surface water, reducing run-on of surface water and subsequent leaching of metals to groundwater, and reducing the risk of airborne exposure to dust. Run-on and run-off controls and revegetation would stabilize waste material by providing additional erosion protection and decrease the infiltration of precipitation and surface water that may leach contaminants to the groundwater.

The threat of human and ecological exposure due to on-site ingestion of waste material, external irradiation from gamma radiation emitted from with waste rock and the intact ore body, and inhalation of radon gas would remain. Institutional controls (existing fencing and signage, existing area and road closures, potential water use restrictions) would limit human and ecological on-site exposure pathways. Surface controls (run-on and run-off measures and sediment detention basins) would reduce discharge of contaminants in surface water and sediment from the mine to Pit and Red Rock creeks. However, leachate captured by the toe drains will require treatment using one of the technologies identified in Alternatives 7 and 8. The permanence of surface controls alone for reducing waste migration to surface water is highly dependent on maintenance activities. Therefore, Alternative 3 is considered to be low to moderately effective for achieving PRAOs.

Construction of surface controls and implementation of institutional controls alone at Juniper Mine would not meet federal or state contaminant-specific ARARs. Contaminant-specific ARARs for groundwater would be met through the concurrent treatment of leachate from the toe drains using one of the technologies described in Alternatives 7 and 8. In addition, if surface controls are unable to reduce COC concentration in surface water, then treatment of surface water may also be required using one of the technologies described in Alternatives 7 and 8.

Location-specific ARARs are expected to be met without any conflicts.

The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. Construction of surface controls would meet the revegetation requirements contained in SMCRA and SMARA. In addition, standards for drainage, diversion structures, waterways, and erosion control contained in

SMARA would also be met. Stormwater generated during construction activities will be managed in accordance with the CWA. Tuolumne County APCD nuisance dust suppression and control requirements are applicable for construction and earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Long-term monitoring and maintenance would be required, especially cleanout of sediment detention basins and revegetation of slopes since waste surfaces are susceptible to erosion. Berms, water control bars, and ditches should also be repaired as necessary. Selecting the appropriate plant species for revegetation, including some hardy cold tolerant plant species in the revegetation seed mixture, would enhance the long-term effectiveness of surface controls. Revegetation areas must be maintained until a vegetative cover has been established or lack of viability demonstrated. In addition, institutional controls would be required to prevent land uses incompatible with the response action. Specifically, land uses that would compromise surface control structures and vegetated surfaces should be precluded.

The objective of this alternative is to reduce contaminant mobility; the volume or toxicity of the contaminants would not be physically reduced. Run-on and run-off controls would stabilize waste sources and reduce contaminant mobility from surface water, leachate, and wind erosion with an increased risk reduction compared to institutional control measures alone (Alternative 2). The mobility of the contaminants would be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure except external irradiation and radon gas emission.

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur due to the waste requiring grading or consolidation and grading. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed.

8.3.2 Implementability

This alternative is both technically and administratively feasible, and could be implemented within one field season. Excavation, grading, consolidation, and slope stabilization require conventional construction practices; materials and construction methods are readily available. Design methods, construction practices, and engineering requirements for installation of berms, ditches, drains, culverts, velocity breaks, water control bars, and sediment detention basins are well documented and understood. Equipment, materials, and labor would be available through the local market.

Installation of a culvert in Pit Creek and a drain at the toe of Waste Rock Pile Nos. 1 and 2 would likely require special construction techniques such as diverting surface water and dewatering excavation areas. Consolidating waste rock excavated from mine roads would require the use of heavy equipment including scrapers, loaders, dozers, and haul trucks. Controlling fugitive dust emissions and storm water discharge during excavation and grading activities would be required. This type of response action alternative could be supplemented in the future with additional response actions such containment measures.

8.3.3 Costs

The total present worth cost for Alternative 3, surface and institutional controls, is estimated to be $577,139 and $920,209 with 5 years and 30 years of operations and maintenance, respectively. The cost for the additional 25 years of operations and maintenance for years 6 through 30 is $343,070. Table 8-2 presents the costs associated with implementing Alternative 3. Assumptions used in preparing the cost estimate are provided in Appendix A. Additional costs for treatment of leachate and potentially surface water if surface controls are not effective, using zero valence iron (Alternative 7) or ion exchange resin (Alternative 8), are presented in Tables 8-6a, 8-6b, 8-7a, and 8-7b. The total present worth cost includes the present value of annual maintenance and monitoring costs, in addition to the capital costs. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

8.4 ALTERNATIVE 4: WASTE ROCK AND SEDIMENT CONSOLIDATION, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS

Consolidation involves grouping similar waste types in a common area for subsequent management. Consolidation is especially applicable when multiple waste areas are present at a mine and management of one large combined waste source is more effective than several smaller waste sources dispersed throughout an area. Consolidation in combination with surface and institutional controls are used primarily to reduce area of exposure, reduce contaminant mobility, and limit direct exposure to contaminants. At Juniper Mine, consolidation is considered a feasible alternative for Waste Rock Piles Nos.1 and 2, the waste rock covered roads, sediment hotspots located in the drainages in the outwash area and in the alluvial fans below these drainages in the canyon reach of Red Rock Creek. Placing material from Waste Rock Pile No.1, the roads, and outwash area drainages on top of Waste Rock Pile No.2 has the added benefit of significantly reducing site risk associated with gamma radiation from Waste Rock Pile No.2.

As discussed in Alternative 3, surface controls are considered a feasible alternative for the mine pit, waste rock piles, and waste rock covered roads. Surface control process options include grading, erosion control and protection, revegetation, run-on and run-off controls, detention and infiltration basins and traps, and flood control and protection. An overview of each process option is presented in Section 7.1.3.1. Institutional controls limit direct exposure through the application of access restrictions (see Alternative 2).

Under this alternative, metals and radionuclides in leachate from a drain installed at the toe of Waste Rock Pile No.2, would require treatment prior to discharge to Pit Creek. In addition surface water from Pit Creek may also require treatment if surface controls are not effective in reducing contaminant migration. Treatment of leachate and potentially surface water would be conducted using either ZVI (Alternative 7) or ion exchange resin (Alternative 8). Waste- and source-specific process options are described below.

Consolidation of Waste Rock Pile No.1 and the waste rock covered roads on top of Waste Rock Pile No.2 and surface controls for the excavated area include:

- Excavation of approximately 25,000 yd^3 of material from Waste Rock Pile No.1 and 1,422 yd^3 of material from waste rock covered roads, hauling of excavated waste rock, and consolidation of the material on top of Waste Rock Pile No. 2. Grade waste on surface of Waste Rock Pile No.2.

- Assume radiological screening and air monitoring for 4 weeks during excavation and grading activities.

- Grading of excavated surface below former Waste Rock Pile No.1 perpendicular to slope to control sheet flow.

- Broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of excavated area to control water running on to the graded surface. Route run on, via drainage pipe, to a sediment detention basin prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of graded area to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Installation of water control bars along the regraded road to slow run off and route storm water away from the waste rock piles.

- Installation of velocity breaks every 100 feet in the existing unlined drainage ditch along the regraded road.

- Installation of a sediment detention basin at the end of the drainage ditch to capture any mine-related sediment before water discharges from the mine site. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Installation of one 18-inch culvert to divert runoff from between Waste Rock Pile Nos. 1 and 2 under Forest Road 5N33.

- Yearly clean out of basins to remove sediment. Repair water control bars and ditches as necessary. Fertilize and reseed sediment detention basin yearly until vegetation established or lack of viability demonstrated.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

Excavation of sediment hotspots from outwash area drainages below Waste Rock Pile Nos. 1 and 2 and the alluvial fans in the canyon reach of Red Rock Creek below these drainages and consolidation on top of Waste Rock Pile No.2:

- Excavation of approximately 135 yd^3 of sediment from the outwash area drainages below Waste Rock Pile No.1, hauling of excavated sediment, and consolidation of the sediment on top of Waste Rock Pile No. 2.

- Excavation of approximately 210 yd^3 of sediment from the outwash area drainages below Waste Rock Pile No.2, hauling of excavated sediment, and consolidation of the sediment on top of Waste Rock Pile No. 2.

- Grading of approximately 1,100 feet of access road from Forest Road 5N33 to the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2.

- Excavation of approximately 1,600 yd^3 of sediment from the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2, hauling of excavated sediment, and consolidation of the sediment on top of Waste Rock Pile No. 2.

- Grading of excavated alluvial fan surfaces perpendicular to slope to control sheet flow. Broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of water control bars along the length of the access road to control runoff along the road surface and direct water toward the inside edge of the road.

- Installation of interceptor berm and ditch on upslope side of graded road to control water running on to graded surface. Route ditch flow, through drainage pipe, to a shallow sediment detention basin on the Red Rock Creek floodplain. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in the sediment detention basin to act as a sediment filter in front of the outlet.

- Yearly clean out of basin to remove sediment. Repair water control bars and ditch as necessary. Fertilize and reseed graded area and sediment detention basin yearly until vegetation established or lack of viability demonstrated.

Surface controls for the Waste Rock Piles Nos. 2 and 3 include:

- Grading of the surface of the two waste rock piles to direct runoff away from oversteep slopes. Stabilize toe of slopes and fill large eroded gullies along slopes of waste rock piles.

- Scarify, fertilize, and seed surface and slopes of the two waste rock piles. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of the two waste rock piles to control water running on to the waste rock pile. Route run on, via drainage pipe, to sediment detention basins prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of the two waste rock piles to capture sediment and control rate of runoff. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Installation of a drain at toe of Waste Rock Pile No. 2 to capture any leachate generated by infiltrating precipitation. Leachate would be discharged for treatment using one of the technologies described in Alternatives 7 and 8.

- Spring and late summer monitoring of leachate from the toe drain for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- After Pit Creek is routed through a culvert, buttress toe of Waste Rock Pile No.2 slope with gabions and regrade to reduce slope.

- Yearly clean out of basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and sediment detention basins yearly until vegetation established or lack of viability demonstrated.

Surface controls in the mine pit include:

- Installation of interceptor berm and ditch on upslope side of mine pit high walls to control water running into pit. Route run on, through drainage pipes, to sediment detention basins prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Broadcast fertilizer and seed on to lower slopes and floor of mine pit to create a vegetative filter for sediment capture and reduce erosion.

- Installation of velocity breaks on pit floor to reduce storm water runoff rate and allow longer settling time in an existing sediment detention basin.

- Route Pit Creek discharge from the mine pit through a culvert to Pit Creek below Waste Rock Pile No.2. Isolation of Pit Creek will reduce erosion of Waste Rock Pile No. 2.

- If surface controls are not successful at removing COCs from water discharging from the pit, then treat Pit Creek discharge from the existing sediment detention basin using one of the treatment systems described in Alternatives 7 and 8.

- Spring runoff and late summer baseflow monitoring of Pit Creek for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Yearly clean out of the sediment detention basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and pit floor yearly until vegetation established or lack of viability demonstrated.

8.4.1 Effectiveness

The implementation of this alternative would provide an additional level of protection beyond that provided by surface and institutional controls (Alternative 3) by reducing the exposed waste rock surface area available for surface water erosion, precipitation infiltration and metals leaching to groundwater, wind erosion, ingestion, and emission of gamma radiation and radon gas. Run-on and run-off controls and revegetation would stabilize waste material by providing additional erosion protection and decrease the infiltration of precipitation that may leach contaminants to groundwater.

The threat of human and ecological exposure due to on-site ingestion of waste material, external irradiation from gamma radiation emitted from waste rock and the intact ore body, and inhalation of radon gas would remain, though the surface area available for exposure would be significantly reduced after consolidation. Surface controls (run-on and run-off measures and sediment detention basins) would reduce discharge of contaminants in surface water and sediment from the mine to Pit and Red Rock creeks. However, leachate captured by the toe drain will require treatment using one of the treatment technologies identified in Alternatives 7 and 8. The permanence of surface controls alone for reducing waste migration to surface water is highly dependent on maintenance activities. Institutional controls (existing fencing and signage, existing area and road closures) would also limit human and ecological on-site exposure pathways and protect the response action. Therefore, Alternative 4 is considered to be moderately effective for achieving PRAOs.

Consolidation of waste, construction of surface controls, and implementation of institutional controls alone at Juniper Mine would not meet federal or state contaminant-specific ARARs. Leaching and release of contaminants to groundwater and surface water would be partially reduced due to a less exposed surface area (consolidation) and run-on and run-off controls. Contaminant-specific ARARs for groundwater would be met through the concurrent treatment of leachate using one of the technologies described in Alternatives 7 and 8. In addition, if surface controls are unable to reduce COC concentration in surface water, then treatment of surface water may also be required using one of the technologies described in Alternatives 7 and 8.

Location-specific ARARs are expected to be met without any conflicts.

The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. Waste consolidation and construction of surface controls would meet the standards for diversion of flow from disturbed areas and revegetation requirements contained in SMCRA. In addition, standards for backfilling, regrading, slope stability, and recontouring; drainage, diversion structures, waterways, and erosion control; and revegetation contained in SMARA would also be met. Stormwater generated during consolidation and construction activities will be managed in accordance with the CWA. Tuolumne County APCD nuisance dust suppression and control requirements are applicable for construction and earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Long-term monitoring and maintenance would be required, especially cleanout of sediment detention basins and revegetation of slopes and excavated areas since waste surfaces are susceptible to erosion. Berms, water control bars, and ditches should also be repaired as necessary. Selecting the appropriate plant species for revegetation, including some hardy cold tolerant plant species in the revegetation seed mixture, would enhance the long-term effectiveness of surface controls. Revegetation areas must be maintained until a vegetative cover has been established or lack of viability demonstrated. In addition, institutional controls would be required to prevent land uses incompatible with the response action. Specifically, land uses that would compromise surface control structures and vegetated surfaces should be precluded.

The objective of this alternative is to reduce contaminant mobility; the volume or toxicity of the contaminants would not be physically reduced. Consolidation, while not reducing volume, would reduce exposed waste surface area. Run-on and run-off controls would stabilize waste sources and reduce contaminant mobility from surface water, leachate, and wind erosion with an increased risk reduction compared to surface and institutional control measures alone (Alternative 3). The mobility of the contaminants would be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure except external irradiation and radon gas emission.

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur due to the relatively large volumes of waste requiring excavation, hauling, consolidation and grading. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed.

8.4.2 Implementability

This alternative is both technically and administratively feasible, and could be implemented within one field season. Excavation, consolidation, grading, and slope stabilization require conventional construction practices; materials and construction methods are readily available. Design methods, construction practices, and engineering requirements for installation of berms, ditches, drains, culverts, velocity breaks, water control bars, and sediment detention basins are well documented and understood. Equipment, materials, and labor would be available through the local market. It is assumed that material from Waste Rock Pile No.3 will be suitable plant-growth media after addition of amendments.

Installation of a culvert in Pit Creek and a drain at the toe of Waste Rock Pile No.2 would likely require special construction techniques such as diverting surface water and dewatering excavation areas. Consolidating waste rock excavated from waste rock piles, roads, and outwash area drainages around the mine would require the use of heavy equipment including scrapers, loaders, dozers, and haul trucks. Controlling fugitive dust emissions and storm water discharge during excavation, hauling, consolidation, and grading activities would be required. This type of response action alternative could be supplemented in the future with additional response actions such containment measures.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating an alternate source of soil suitable for plant-growth if material from Waste Rock Pile No.3 is not suitable, and (2) controlling fugitive dust emissions and storm water discharge during response activities. However, these concerns are applicable to other response action alternatives being considered for the site.

8.4.3 Costs

The total present worth cost for Alternative 4, waste rock and sediment consolidation, and surface and institutional controls, is estimated to be $667,289 and $1,028,971 with 5 years and 30 years of operations and maintenance, respectively. The cost for the additional 25 years of operations and maintenance for years 6 through 30 is $361,682. Table 8-3 presents the costs associated with implementing Alternative 4. Assumptions used in preparing the cost estimate are provided in Appendix A. Additional costs for treatment of leachate and potentially surface water if surface controls are not effective, using zero valence iron (Alternative 7) or ion exchange resin (Alternative 8), are presented in Tables 8-6a, 8-6b, 8-7a, and 8-7b. The total present worth cost includes the present value of annual maintenance and monitoring costs, in addition to the capital costs. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

8.5 ALTERNATIVE 5: WASTE ROCK AND SEDIMENT CONSOLIDATION, EARTHEN COVER WITH GEOMEMBRANE LINER, SLURRY WALL, SURFACE AND INSTITUTIONAL CONTROLS

Consolidation and containment of wastes combined with surface and institutional controls is used primarily to reduce exposure to and mobility of contaminants. Consolidation involves grouping similar waste types in a common area for subsequent management. Consolidation is used primarily to reduce the area of exposure. The physical covering of wastes during containment reduces or eliminates the potential health risk that may be associated with exposure (external irradiation or airborne releases of particulates) to the contaminated media. Installing a geomembrane liner under the cover also reduces infiltration of water and the subsequent mobilization of contaminants. Construction of a slurry wall up gradient of the waste will direct groundwater around the waste, avoiding contact with the waste and subsequent mobilization of contaminants. Surface and institutional controls are used to reduce contaminant mobility and limit direct exposure to contaminants in those areas where containment is not employed.

At Juniper Mine, consolidation is considered a feasible alternative for Waste Rock Pile No.1, the waste rock covered roads, and sediment hotspots located in the drainages in the outwash area and in the alluvial fans below these drainages in the canyon reach of Red Rock Creek. Placing material from these sources on top of Waste Rock Pile No.2 has the added benefit of significantly reducing site risk associated with gamma radiation from Waste Rock Pile No.2.

Containing the consolidated wastes in place would involve grading, construction of an earthen cover with flexible geomembrane liner, construction of a slurry wall up gradient of the waste, and implementation of surface and institutional control measures. Installation of a geomembrane liner under the cover and an up gradient slurry wall are necessary because (1) metals in the mine waste are leachable; and (2) the metals concentration in leachate exceeds metals concentrations in surface water and groundwater.

The containment steps would generally include the following: (1) installing a 30-thousandth of an inch (mil) flexible geomembrane liner, drainage layer, and a minimum of 36 inches of cover on top of the waste, (2) constructing a slurry wall up gradient of the waste, and (3) grading and revegetating the disturbed areas and the cover. Surface control measures will be used to divert surface water away from the cover. Material from Waste Rock Pile No.3, essentially overburden from above the ore body with metal and radionuclide concentrations not significantly different from site background levels, will be used for the earthen cover. A drain will be installed at the toe of Waste Rock Pile No.2, to capture any groundwater not diverted by the slurry wall, for potential treatment. A conceptual design of the earthen cover and liner is shown in Figure 8-1.

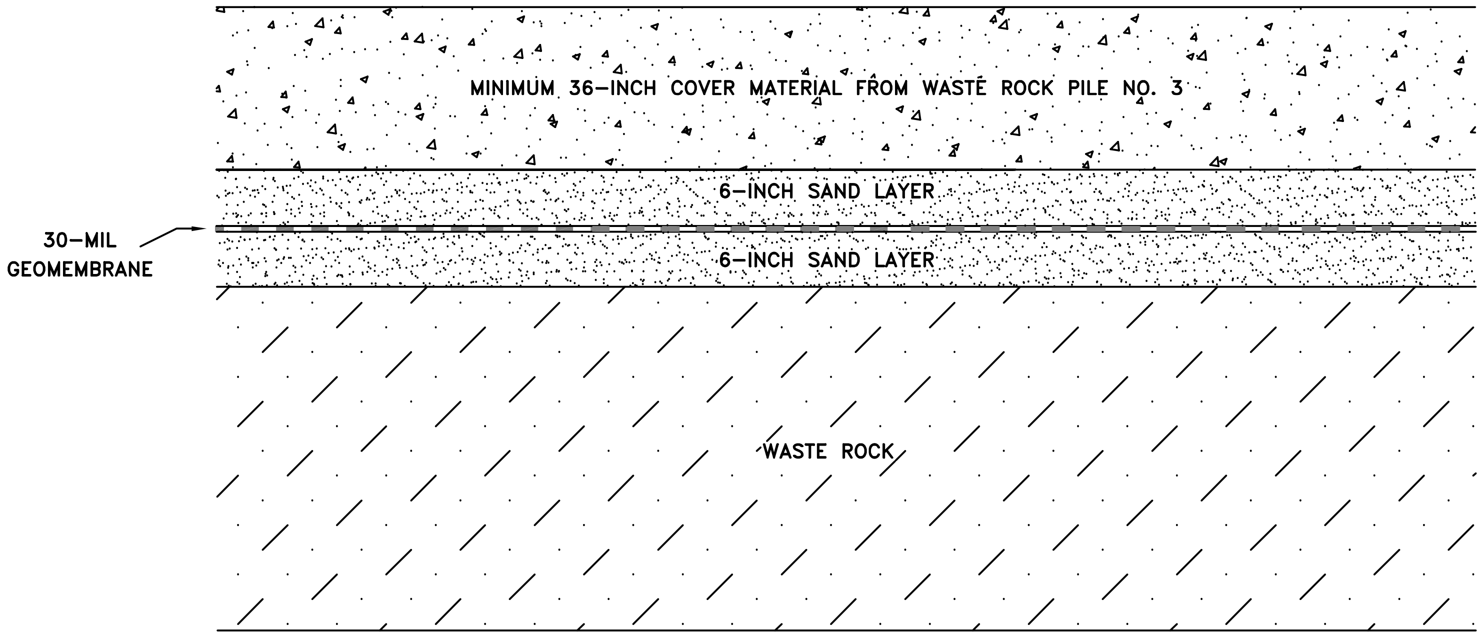
Surface controls will also be used to reduce mobility of mine waste not addressed by consolidation and containment. Surface control process options include grading, erosion control and protection, revegetation, run-on and run-off controls, detention and infiltration basins and traps, and flood control and protection. An overview of each process option is presented in Section 7.1.3.1. Institutional controls limit direct exposure through the application of access restrictions (see Alternative 2).

Under this alternative, metals and radionuclides in Pit Creek may also require treatment if surface controls within the mine pit are not effective in reducing contaminant migration. Treatment of surface water, if necessary, would be conducted using either ZVI (Alternative 7) or ion exchange resin (Alternative 8). Waste- and source-specific process options are described below.

Consolidation of Waste Rock Pile No.1 and the waste rock covered roads on top of Waste Rock Pile No.2 and surface controls for the excavated area include:

- Excavation of approximately 25,000 yd^3 of material from Waste Rock Pile No.1 and 1,422 yd^3 of material from waste rock covered roads, hauling of excavated waste rock, and consolidation of the material on top of Waste Rock Pile No. 2. Grade waste on surface of Waste Rock Pile No.2.

- Assume radiological screening and air monitoring for 8 weeks for all excavation and grading activities.



EARTHEN COVER AND LINER

NOTE: A BOTTOM LINER AND LEACHATE COLLECTION RECOVERY SYSTEM IS NOT USED BECAUSE SHALLOW GROUNDWATER IS DIVERTED AROUND WASTE UNIT USING A SLURRY WALL.

NOT TO SCALE

FIGURE 8-1

CONCEPTUAL DESIGN,
ALTERNATIVE 5
JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

TETRA TECH EM INC.

- Grading of excavated surface below former Waste Rock Pile No.1 perpendicular to slope to control sheet flow.

- Broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of excavated area to control water running on to the graded surface. Route run on, via drainage pipe, to a sediment detention basin prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of graded area to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Installation of water control bars along the regraded road to slow run off and route storm water away from the waste rock piles.

- Installation of velocity breaks every 100 feet in the existing unlined drainage ditch along the regraded road.

- Installation of a sediment detention basin at the end of the drainage ditch to capture any mine-related sediment before water discharges from the mine site. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Installation of one 18-inch culvert to divert runoff from between Waste Rock Pile Nos. 1 and 2 under Forest Road 5N33.

- Yearly clean out of basins to remove sediment. Repair water control bars and ditches as necessary. Fertilize and reseed sediment detention basin yearly until vegetation established or lack of viability demonstrated.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

Excavation of sediment hotspots from outwash area drainages below Waste Rock Pile Nos. 1 and 2 and the alluvial fans in the canyon reach of Red Rock Creek below these drainages and consolidation on top of Waste Rock Pile No.2:

- Excavation of approximately 135 yd^3 of sediment from the outwash area drainages below Waste Rock Pile No.1, hauling of excavated sediment, and consolidation of the sediment on top of Waste Rock Pile No. 2.

- Excavation of approximately 210 yd^3 of sediment from the outwash area drainages below Waste Rock Pile No.2, hauling of excavated sediment, and consolidation of the sediment on top of Waste Rock Pile No. 2.

- Grading of approximately 1,100 feet of access road from Forest Road 5N33 to the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2.

- Excavation of approximately 1,600 yd^3 of sediment from the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2, hauling of excavated sediment, and consolidation of the sediment on top of Waste Rock Pile No. 2.

- Grading of excavated alluvial fan surfaces perpendicular to slope to control sheet flow. Broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of water control bars along the length of the access road to control runoff along the road surface and direct water toward the inside edge of the road.

- Installation of interceptor berm and ditch on upslope side of graded road to control water running on to graded surface. Route ditch flow, through drainage pipe, to a shallow sediment detention basin on the Red Rock Creek floodplain. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in the sediment detention basin to act as a sediment filter in front of the outlet.

- Yearly clean out of basin to remove sediment. Repair water control bars and ditch as necessary. Fertilize and reseed graded area and sediment detention basin yearly until vegetation established or lack of viability demonstrated.

Containment of consolidated waste at Waste Rock Pile No.2 includes:

- Placement and grading of a sand layer on top of consolidated waste.

- Placement of a flexible geomembrane liner on top of sand layer.

- Placement and grading of a sand drainage layer on top of geomembrane liner.

- Rehabilitation of mine haul road from Waste Rock Pile No. 3.

- Excavation of a portion of the material from Waste Rock Pile No.3, hauling of excavated material to Waste Rock Pile No.2, and placement of material on top of drainage layer as a final cover.

- Grade surface of cover material to direct runoff away from oversteep slopes. Stabilize toe of slopes and fill large eroded gullies along slopes of waste rock pile.

- Scarify, fertilize, and seed surface and slopes of the waste rock pile. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of the waste rock pile to control water running on to the waste rock pile. Route run on, via drainage pipe, to a sediment detention basin prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of the waste rock pile to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in the sediment detention basin to act as a sediment filter in front of the outlet.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Installation of a slurry wall upslope of Waste Rock Pile No.2 to divert groundwater into the mine pit before it flows through Waste Rock Pile No.2.

- Installation of a drain at toe of Waste Rock Pile No. 2 to capture any leachate generated by groundwater not diverted by slurry wall. Leachate would be discharged for treatment using one of the technologies described in Alternatives 7 and 8.

- Spring and late summer monitoring of leachate from the toe drain for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- After Pit Creek is routed through a culvert, buttress toe of Waste Rock Pile No.2 slope with gabions and regrade to reduce slope.

- Yearly clean out of basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and sediment detention basins yearly until vegetation established or lack of viability demonstrated.

Surface controls for the remainder of Waste Rock Pile No. 3 include:

- Grading of the remaining surface of the waste rock pile to direct runoff away from oversteep slopes. Stabilize toe of slopes and fill large eroded gullies along slopes of waste rock pile.

- Scarify, fertilize, and seed surface and slopes of the two waste rock piles. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of the waste rock pile to control water running on to the waste rock pile. Route run on, via drainage pipe, to a sediment detention basin prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of the waste rock pile to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in the sediment detention basin to act as a sediment filter in front of the outlet.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Yearly clean out of basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and sediment detention basins yearly until vegetation established or lack of viability demonstrated.

Surface controls in the mine pit include:

- Installation of interceptor berm and ditch on upslope side of mine pit high walls to control water running into pit. Route run on, through drainage pipes, to sediment detention basins prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Broadcast fertilizer and seed on to lower slopes and floor of mine pit to create a vegetative filter for sediment capture and reduce erosion.

- Installation of velocity breaks on pit floor to reduce storm water runoff rate and allow longer settling time in an existing sediment detention basin.

- Route Pit Creek discharge from the mine pit through a culvert to Pit Creek below Waste Rock Pile No.2. Isolation of Pit Creek will reduce erosion of Waste Rock Pile No. 2.

- If surface controls are not successful at removing COCs from water discharging from the pit, then treat Pit Creek discharge from the existing sediment detention basin using one of the treatment systems described in Alternatives 7 and 8.

- Spring runoff and late summer baseflow monitoring of Pit Creek for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Yearly clean out of the sediment detention basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and pit floor yearly until vegetation established or lack of viability demonstrated.

8.5.1 Effectiveness

The implementation of this alternative would provide an additional level of protection beyond that provided by consolidation and surface and institutional controls (Alternative 4) by further reducing the threat of human and ecological ingestion of waste material, reducing gamma radiation emission, and reducing the risk of airborne exposure to dust and radon gas. Containing waste and subsequent revegetation and run-on and run-off controls would stabilize the cover surface by providing additional erosion protection. The geomembrane liner under the earthen cover will decrease the infiltration of precipitation that may leach metals from the waste rock to groundwater and will also reduce radon gas emission. Construction of a slurry wall upslope of Waste Rock Pile No.2 would reduce leaching of metals from waste rock through groundwater through flow.

The threat of human and ecological exposure due to ingestion of waste material, external irradiation from gamma radiation, and inhalation of dust and radon gas would remain at the mine pit. Surface controls (run-on and run-off measures and sediment detention basins) would reduce discharge of contaminants in surface water and sediment from the mine to Pit and Red Rock creeks. The geomembrane liner will reduce precipitation infiltration and the slurry wall will divert groundwater around the waste rock; therefore leachate should not be generated. Any leachate that is generated will be captured by the drain at the toe of Waste Rock Pile No.2 and will require treatment using one of the technologies identified in Alternative 7 and 8. The permanence of surface controls alone for reducing waste migration to surface water is highly dependent on maintenance activities. Institutional controls (existing fencing and signage, existing area and road closures) would also limit human and ecological on-site exposure pathways and protect the response action. Therefore, Alternative 5 is considered to be moderately to highly effective for achieving PRAOs.

Consolidation and containment of waste, construction of surface controls, and implementation of institutional controls alone at Juniper Mine would not meet federal or state contaminant-specific ARARs. Leaching and release of contaminants to groundwater and surface water would be significantly reduced because the primary waste sources of concern would be physically isolated using an earthen cover with a geomembrane liner, groundwater would be diverted around mine waste to avoid leachate generation, and erosion of waste from the mine pit would be managed using run-on and run-off controls. Contaminant-specific ARARs for groundwater would be met through the concurrent treatment of leachate using one of the technologies described in Alternatives 7 and 8. Contaminant-specific ARARs for surface water would be met through surface controls. If surface controls are unable to reduce COC concentration in surface

water, then treatment of surface water may also be required using one of the technologies described in Alternatives 7 and 8.

Location-specific ARARs are expected to be met without any conflicts.

The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. Waste consolidation, containment, and construction of surface controls would meet the standards for diversion of flow from disturbed areas and revegetation requirements contained in SMCRA. In addition, standards for backfilling, regrading, slope stability, and recontouring; drainage, diversion structures, waterways, and erosion control; and revegetation contained in SMARA would also be met. Waste rock would be managed as a Group A waste subject to the design and siting criteria specified under Water Code Section 13172. An engineered alternative to the prescriptive standard for a LCRS would be used to protect groundwater from leachate generation. The engineered alternative would involve placement of a slurry wall hydraulically up gradient of the covered waste rock to divert shallow groundwater around the waste unit. Stormwater generated during consolidation and construction activities will be managed in accordance with the CWA. Tuolumne County APCD nuisance dust suppression and control requirements are applicable for construction and earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Under this alternative, the cover would have to be inspected to ensure that the vegetation becomes established and continues to perform as designed. Consequently, long-term monitoring and maintenance would be required, especially the revegetated slopes since surfaces are susceptible to erosion. The waste cover would be the component most vulnerable to any damage or degradation that might occur. The cover would be susceptible to settlement, surface water ponding, erosion, and disruption of cover integrity by vehicles, deep-rooting vegetation, and burrowing animals. The actual design life of the cover is not certain; however, since the cover would be periodically inspected, the required maintenance could be determined and implemented. The long-term effectiveness of containing the waste in place would be enhanced by determining the proper cover design and appropriate grading layout, and by selecting the appropriate plant species for revegetation. In addition, institutional controls would be required to prevent land uses incompatible with the response action. Specifically, land uses that would compromise the waste cover should be precluded.

Long-term monitoring and maintenance of surface controls in the mine pit and excavation areas would also be required, especially cleanout of sediment detention basins and revegetation of slopes and excavated areas since waste surfaces are susceptible to erosion. Berms, water control bars, and ditches should also be repaired as necessary. The selection of appropriate plant species for revegetation, including some hardy cold tolerant plant species in the revegetation seed mixture, would enhance the long-term effectiveness of surface controls. Revegetation areas must be maintained until a vegetative cover has been established or lack of viability demonstrated. In addition, institutional controls would be required to prevent land uses incompatible with the surface controls. Specifically, land uses that would compromise surface control structures and vegetated surfaces should be precluded.

The objective of this alternative is to reduce contaminant mobility; the volume or toxicity of the contaminants would not be physically reduced. Consolidating and containing the waste would stabilize these sources, reduce emission of gamma radiation, and reduce contaminant mobility from surface water run-off, precipitation infiltration and leachate generation, dust generation, and radon gas capture compared to consolidation, and surface and institutional controls alone (Alternative 4). Run-on and run-off controls in the mine pit and excavated areas would stabilize waste sources and reduce contaminant mobility from surface water and wind erosion. The mobility of the contaminants would be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure; however, emission of gamma radiation and radon gas from the mine pit would remain.

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. Short-term risks of exposure to contaminated material, radon gas, and gamma radiation would be a potential for the site worker during excavation, consolidation, grading, and cover installation; and construction of run-on and run-off controls. Therefore, on-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. Short-term air quality impacts to the surrounding environment may occur due to the relatively large volumes of waste requiring consolidation and grading. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. Short-term risks of physical injury during construction activities would also exist, as well as off site from increased truck traffic required to transport construction material to Juniper Mine.

8.5.2 Implementability

This alternative is both technically and administratively feasible, and could be implemented within one field season. The consolidation, regrading, and revegetation require conventional construction practices; materials and construction methods are readily available. It is assumed that material from Waste Rock Pile No.3 will be used for the earthen cover, and that a local source (within 30 miles) for the sand used in leveling and liner construction is available. Also, design methods and requirements are well documented and understood. Installation of the single geomembrane liner and earthen cover would require the services of a contractor experienced in the proper installation of specialized covers and liners.

Installation of a culvert in Pit Creek and a drain at the toe of Waste Rock Pile No.2 would likely require special construction techniques such as diverting surface water and dewatering excavation areas. Consolidating and containing the waste materials in place would require the use of heavy equipment including scrapers, loaders, dozers, and haul trucks. The heavy equipment required to perform these tasks can be operated on slopes with a maximum steepness of approximately 2 to 1, and some of the site area approaches this steepness. This type of response action alternative could be supplemented in the future with additional response actions such as groundwater control measures. However, future response of the materials would be more costly after a cover has been installed.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating an alternate source of soil suitable for plant-growth if material from Waste Rock Pile No.3 is not suitable, (2) controlling fugitive dust emissions and storm water discharge during response action activities, and (3) shortened construction season due to inclimate weather or heavy snow pack. However, these concerns are applicable to other response action alternatives being considered for the site.

8.5.3 Costs

The total present worth cost for Alternative 5, waste rock and sediment consolidation, earthen cover with geomembrane liner, and surface and institutional controls, is estimated to be $1,998,284 and $2,330,342 with 5 years and 30 years of operations and maintenance, respectively. The cost for the additional 25 years of operations and maintenance for years 6 through 30 is $332,058. Table 8-4 presents the costs associated with implementing Alternative 5. Assumptions used in preparing the cost estimate are provided in Appendix A. Additional costs for treatment of leachate and potentially surface water if

surface controls are not effective, using zero valence iron (Alternative 7) or ion exchange resin (Alternative 8), are presented in Tables 8-6a, 8-6b, 8-7a, and 8-7b. The total present worth cost includes the present value of annual maintenance and monitoring costs, in addition to the capital costs. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

8.6 ALTERNATIVE 6: WASTE ROCK AND SEDIMENT CONSOLIDATION IN AN ENGINEERED GROUP A MINE WASTE REPOSITORY WITHIN THE PIT; SURFACE AND INSTITUTIONAL CONTROLS

Under this alternative, waste rock from Waste Rock Pile Nos. 1 and 2 and the mine roads, and sediment from the outwash areas would be excavated, hauled to, and placed in an on-site, Group A mine waste repository constructed within the existing mine pit. Excavation and placement of mine waste in an on-site repository, in combination with surface and institutional controls, is used primarily to reduce the area of exposure and mobility of contaminants. The physical containment of waste under a cover with a geomembrane liner reduces the potential health risk that may be associated with exposure (external irradiation, airborne releases of particulates, and radon gas) to the contaminated media. Construction of an under drain at the base of the repository and a geomembrane liner around the repository sidewalls is necessary to minimize groundwater contact with the mine waste, while installation of a geomembrane liner under the cover will prevent infiltration of precipitation as the metals and radionuclides in the mine waste are leachable. Surface control measures will be used to divert surface water away from the repository and to minimize the potential for infiltration precipitation into the consolidated mine waste.

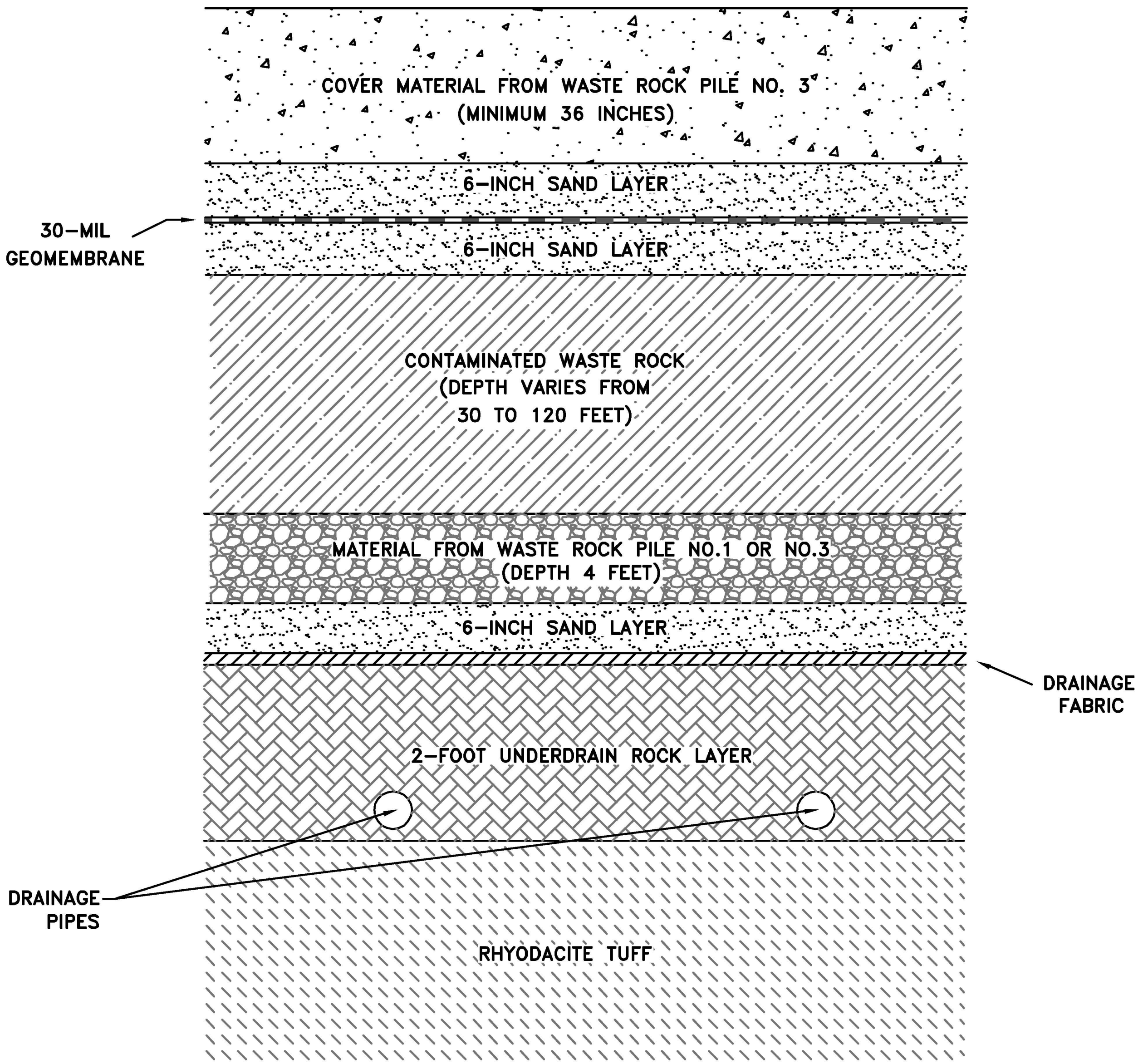
At Juniper Mine, consolidation of mine waste in an on-site repository within the mine pit is considered a feasible alternative for all mine waste. Placing material on top of the intact ore body and consolidated material from Waste Rock Pile No.2, two sources emitting high levels of gamma radiation and radon gas, has the added benefit of significantly reducing site risk associated with gamma radiation and radon gas. Containment of the consolidated materials in the mine pit would involve: 1) construction of an under drain (gravel, perforated polyvinyl chloride (PVC) piping, drainage fabric, and sand layer) to control groundwater elevation, 2) placement of 4 feet of material from Waste Rock Pile No. 1 or No. 3 above the under drain to reduce the potential for leaching of radionuclides to shallow groundwater, 3) placement of materials excavated from Waste Rock Pile No.2, Waste Rock Pile No.1, the mine roads, and outwash areas inside the repository, 4) placement of a 30-mil flexible geomembrane liner, 5) placement of a sand drainage layer, and 6) placement of a portion of the volume of Waste Rock Pile No. 3 as the final cover

for the repository. The material at Waste Rock Pile No.3 is essentially overburden from above the ore body, with metal and radionuclide concentrations not significantly different from site background levels. A conceptual design of the on-site, Group A mine waste repository is shown in Figure 8-2.

RESRAD was used to determine the appropriate thickness of cover material needed to reduce gamma radiation exposure below EPA-established acceptable excess dose limit (15 mrem/year). Preliminary RESRAD modeling indicated that a clean (uncontaminated) layer of soil 18 inches thick placed over the most contaminated Waste Rock Pile No.2 would be sufficient to adequately mitigate gamma radiation exposure to below acceptable levels for a recreational visitor. If material from a relatively clean on-site source were used as a cover (e.g. Waste Rock Pile No.1 or No.3), then an additional safety factor of two (increasing the cover depth from 18 inches to 36 inches) should be applied to ensure adequate mitigation of gamma radiation exposure. RESRAD modeling of gamma radiation exposure due to Ra-226 in Waste Rock Pile No.3 verified that the total radiation dose would be below the acceptable excess dose limit of 15 mrem/year.

Surface control measures will be used to divert surface water away from the mine pit and repository, to minimize the potential for infiltration precipitation into the consolidated mine waste, and to reduce run off and erosion from the repository cover and excavated areas. Surface control process options include grading, erosion control and protection, revegetation, run-on and run-off controls, detention and infiltration basins and traps, and flood control and protection. An overview of each surface process option is presented in Section 7.1.3.1. Institutional controls limit direct exposure through the application of access restrictions (see Alternative 2).

Under this alternative, metals and radionuclides in the small volume of leachate that could potentially discharge from the repository under drain may require treatment over the first few years following repository construction. Leachate, if generated, will co-mingle with groundwater in the under drain prior to treatment. In addition, groundwater discharging from the under drain beneath the repository may also require treatment if metal and radionuclide concentrations are found to exceed up gradient groundwater concentrations. Treatment of groundwater, if necessary, will be conducted using either ZVI (Alternative 7) or ion exchange resin (Alternative 8). Waste- and source-specific process options are described below.



NOT TO SCALE

FIGURE 8-2

CONCEPTUAL DESIGN,
ALTERNATIVE 6
JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

TETRA TECH, EM INC.

Excavation, hauling, and consolidation of all mine waste in mine pit repository includes:

- Rehabilitation of mine haul road originating at Waste Rock Pile No.3, passing above the pit high wall, and traversing down the side of the mountain to Waste Rock Pile No.1.

- Construction of an under drain, using gravel and perforated drain pipe, to minimize groundwater contact with the bottom of the repository.

- Placement of drainage fabric and a sand layer over the under drain to minimize loss of waste material to the under drain.

- Excavation of approximately 169,000 yd^3 of material from Waste Rock Pile No.2, 25,000 yd^3 of material from Waste Rock Pile No.1, and 1,422 yd^3 of material from waste rock covered roads. Hauling of excavated material to and consolidation in the repository in the preceding order of excavation.

- Placement of a 30-mil flexible geomembrane liner and drainage fabric between the mine waste and the pit side and high walls as the repository is being filled.

- Assume radiological screening and air monitoring for 14 weeks for all excavation and grading activities.

- Grading of approximately 1,100 feet of access road from Forest Road 5N33 to the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2.

- Excavation, hauling, and placement of 4 feet of buffer material from Waste Rock Pile No.1 or No. 2 above the drainage fabric and below the contaminated waste rock layer.

- Excavation of approximately 135 yd^3 of sediment from the outwash area drainages below Waste Rock Pile No.1, approximately 210 yd^3 of sediment from the outwash area drainages below Waste Rock Pile No.2, and approximately 1,600 yd^3 of sediment from the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2. Hauling of excavated sediment to and consolidation in the repository.

- Placement and grading of a sand layer on top of consolidated waste.

- Placement of a 30-mil flexible geomembrane liner over the sand layer and consolidated waste.

- Placement and grading of a sand layer on top of geomembrane liner for drainage.

- Excavation, hauling, and placement of cover material from Waste Rock Pile No.3 (approximately 18,900 yd^3) on top of the repository as the final cover.

- Grade surface of cover material to direct runoff away from repository slopes.

- Install lined interceptor ditches in final cover to control water movement on the surface of the cover.

- Broadcast fertilizer and seed on to graded final cover to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of repository to control water running on to the graded surface. Route run on, via drainage pipe, to a sediment detention basin prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin below repository to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Yearly clean out of basins to remove sediment. Repair interceptor ditches and velocity breaks as necessary. Fertilize and reseed sediment detention basin yearly until vegetation established or lack of viability demonstrated.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Spring and summer monitoring of the under drain discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead to document attenuation of leachate.

Restoration of excavated areas includes:

- Grading of excavated surface below former Waste Rock Pile Nos.1 and 2 perpendicular to slope to control sheet flow.

- Grading of excavated alluvial fan surfaces perpendicular to slope to control sheet flow.

- Grading of Pit Creek channel from the under drain discharge to the existing sediment detention basin at Forest Road 5N33 and installation of velocity breaks along the graded Pit Creek channel.

- Broadcast fertilizer and seed on to graded areas to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of excavated areas to control water running on to the graded surfaces. Route run on, via drainage pipe, to sediment detention basins prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of graded areas to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basins to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Grade surface of excavated road surfaces and remove temporary access road to the canyon reach of Red Rock Creek. Broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of water control bars along the regraded roads to slow run off and direct water toward the inside edge of the road.

- Installation of velocity breaks every 100 feet in the existing unlined drainage ditch along the regraded roads.

- Installation of a sediment detention basin at the end of road side drainage ditches to capture any sediment before water discharges from the mine site. Fertilize and seed each sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in each sediment detention basin to act as a sediment filter in front of the outlet.

- Installation of one 18-inch culvert to divert runoff from between Waste Rock Pile Nos. 1 and 2 under Forest Road 5N33.

- Yearly clean out of basins to remove sediment. Repair water control bars and ditches as necessary. Fertilize and reseed sediment detention basin yearly until vegetation established or lack of viability demonstrated.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Spring runoff and late summer baseflow monitoring of Pit Creek for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

Surface controls for the remainder of Waste Rock Pile No. 3 include:

- Grading of the remaining surface of the waste rock pile to direct runoff away from oversteep slopes. Stabilize toe of slopes and fill large eroded gullies along slopes of waste rock pile.

- Scarify, fertilize, and seed surface and slopes of the two waste rock piles. Install wattles to control sheet flow and direct water perpendicular to slope.

- Installation of interceptor berm and ditch on upslope side of the waste rock pile to control water running on to the waste rock pile. Route run on, via drainage pipe, to a sediment detention basin prior to discharge off site.

- Installation of velocity breaks every 100 feet in unlined drainage ditches.

- Installation of a sediment detention basin on lowest point of the waste rock pile to capture sediment and control rate of runoff. Fertilize and seed the sediment detention basin to increase sediment capture and facilitate uranium precipitation on organic material.

- Installation of straw bales in the sediment detention basin to act as a sediment filter in front of the outlet.

- Spring monitoring of sediment detention basin discharge for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead.

- Yearly clean out of basins to remove sediment. Repair berms and ditches as necessary. Fertilize and reseed slopes and sediment detention basins yearly until vegetation established or lack of viability demonstrated.

8.6.1 Effectiveness

The implementation of this alternative would provide an additional level of protection beyond that provided by consolidation, earthen cover with geomembrane liner, and surface and institutional controls (Alternative 5) by eliminating the threat of human and ecological exposure due to ingestion of contaminants in the mine pit, eliminating gamma emissions from the mine pit, eliminating physical hazards associated with the pit high wall, and controlling dust and radon gas emission from the mine pit through covering of the waste. The geomembrane liner under the earthen cover will decrease the infiltration of precipitation that could leach metals from the waste rock to groundwater and reduce radon gas emission. An under drain will minimize groundwater contact with waste material placed in the repository. Treatment of groundwater may be required (See Alternative 7 or 8) if the concentration of metals and radionuclides in leachate from the repository (if generated) or groundwater from the under drain exceed concentrations in groundwater up gradient of the mine site.

The threat of direct human and ecological exposure would be minimized by this alternative. The potential for ingestion, external irradiation from gamma radiation, physical hazards, and inhalation of dust and radon gas would also be minimized. In addition, isolating the waste would provide environmental protection by reducing erosion of mine waste into surface water, and by reducing the infiltration of precipitation and generation and mobilization of leachate to groundwater. Institutional controls (existing area and road closures) would also limit human and ecological on-site exposure pathways and protect the response action. Therefore, Alternative 6 is considered to be highly effective for achieving the PRAOs.

Consolidation and covering of waste at Juniper Mine would meet federal and state contaminant-specific ARARs. Leaching and release of contaminants to groundwater and surface water would be reduced

because the mine waste would be physically isolated from the environment. Groundwater discharging from the under drain beneath the repository may exceed water quality standards and applicable benchmarks due to natural contact with the native ore body. In fact, groundwater up gradient of the site has also been shown to exceed water quality standards and applicable benchmarks. Treatment of naturally occurring levels of chemicals in groundwater to a more stringent benchmark or standards is prohibited under CERCLA 104(a)(3)(A). Therefore, groundwater discharging from the under drain will only be treated, if necessary, to metal and radionuclide concentrations found in up gradient groundwater if the effluent is discharged to groundwater. However, if the effluent is discharge to surface water, then the COCs must be treated to their respective MCLs.

Location-specific ARARs are expected to be met without any conflicts.

The mine wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. Waste consolidation, containment, and construction of surface controls would meet the standards for diversion of flow from disturbed areas and revegetation requirements contained in SMCRA. In addition, standards for backfilling, regrading, slope stability, and recontouring; drainage, diversion structures, waterways, and erosion control; and revegetation contained in SMARA would also be met. Waste rock would be managed as a Group A waste subject to the design and siting criteria specified under Water Code Section 13172. A clay liner and LCRS will not be constructed at the base of the repository. Instead, any leachate generated will be treated as it is discharged from the under drain. Stormwater generated during consolidation and construction activities will be managed in accordance with the CWA. Tuolumne County APCD nuisance dust suppression and control requirements are applicable for construction and earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

The long-term effectiveness and permanence of the repository is dependent upon proper maintenance, including long-term monitoring and routine inspections, to ensure that the system performs as designed. The repository cover would be the component most vulnerable to any damage or degradation that might occur. Multi-layered covers are susceptible to ponding of surface water, erosion, settlement, and disruption of the cover integrity by vehicles, deep-rooting vegetation, and burrowing animals. The actual design life of the repository is not certain; however, since the repository would be periodically inspected,

the required maintenance could be determined and implemented. In addition, institutional controls would be required to prevent land uses incompatible with the site. Specifically, land uses that would compromise the repository cover should be precluded.

The objective of this alternative is to reduce contaminant mobility; the volume or toxicity of the contaminants would not be physically reduced. Consolidating and containing the waste in a repository would reduce the number of sources, minimize external irradiation from gamma radiation, minimize contaminant mobility from surface water run-off, minimize precipitation infiltration and leachate generation, eliminate dust generation, eliminate physical hazards, and minimize emission of radon gas through the use of an impermeable liner that covers the mine waste. The mobility of the contaminants is expected to be reduced to an extent that would result in an overall risk reduction from completed pathways and routes of exposure.

The construction phase of this alternative would likely be accomplished within two field seasons; therefore, impacts associated with erosion during spring melt will be minimized with surface controls installed prior to demobilization for the intervening winter. Short-term risks of exposure to contaminated material, radon gas, and gamma radiation would be a potential for the site worker during excavation, hauling, consolidation of waste; during construction of the repository under drain and cover; and during construction of run-on and run-off controls. Therefore, on-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. Short-term air quality impacts to the surrounding environment may occur due to the relatively large volumes of waste requiring consolidation and hauling to the repository. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. Short-term risks of physical injury during construction activities would also exist, as well as off site from increased truck traffic required to transport construction material to Juniper Mine.

8.6.2 Implementability

This alternative is both technically and administratively feasible, and would be implemented within two field seasons. Excavation, consolidation, and construction of a repository with a multi-layered cover is considered a conventional construction practice; materials and construction methods are readily available. It is assumed that a portion of the material from Waste Rock Pile No.3 will be used for the earthen cover, and that a local source (within 30 miles) for the gravel used in the under drain and the sand used in

leveling and liner construction is available. Also, design methods and requirements are well documented and understood. Construction of the repository may require the services of a contractor experienced in the proper component installation procedures.

Excavation, consolidation, and construction of the repository would require the use of heavy equipment including scrapers, loaders, dozers, and haul trucks. The heavy equipment required to perform these tasks can be operated on slopes with a maximum steepness of approximately 2 to 1, and some of the site area approaches this steepness.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating an alternate source of soil suitable for plant-growth if material from Waste Rock Pile No.3 is not suitable, (2) controlling fugitive dust emissions and storm water discharge during response action activities, and (3) shortened construction season due to inclimate weather or heavy snow pack. However, these concerns are applicable to other response action alternatives being considered for the site.

8.6.3 Costs

The total present worth cost for Alternative 6, waste rock and sediment consolidation in pit; construction of engineered drain and cover; and surface and institutional controls, is estimated to be $2,387,509 and $2,735,365 with 5 years and 30 years of operations and maintenance, respectively. The cost for the additional 25 years of operations and maintenance for years 6 through 30 is $347,856. Table 8-5 presents the costs associated with implementing Alternative 6. Assumptions used in preparing the cost estimate are provided in Appendix A. Additional costs for treatment of groundwater discharge from the repository under drain, using zero valence iron (Alternative 7) or ion exchange resin (Alternative 8), are presented in Tables 8-6a, 8-6b, 8-7a, and 8-7b. The total present worth cost includes the present value of annual maintenance and monitoring costs, in addition to the capital costs. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

8.7 ALTERNATIVE 7: METALS REMOVAL FROM SURFACE WATER, GROUNDWATER, AND LEACHATE USING A ZERO VALENCE IRON REACTOR

Under this alternative, metals and radionuclides in leachate from the waste rock pile toe drains (Alternatives 3, 4, and 5) and from the repository under drain (Alternative 6) would be concentrated on ZVI using an on-site, passive ZVI flow-through reactor. Surface water from Pit Creek may also require treatment if surface controls (Alternatives 3, 4, and 5) are not effective in reducing contaminant migration. Alternative 7 has been divided into two subparts in order to evaluate the issues related to treatment of water to groundwater background concentrations (Alternative 7a) or to federal MCLs (Alternative 7b). Water impacted by mining activities would be treated to background groundwater concentrations (Alternative 7a) or to federal MCLs (Alternative 7b). Under Alternative 7a, water treated to background groundwater concentrations would be percolated into the Near Meadow using three 200-foot long below grade perforated pipes (discharge option 1), percolated into Sardine Meadow using three 200-foot long below grade perforated pipes (discharge option 2), or discharged to a gallery of up to ten 100-foot deep infiltration wells (discharge option 3) (see Figures 8-3 and 8-4). Under Alternative 7b, water treated to federal MCLs would be discharged directly into Pit Creek. A description of discharge approaches for treatment system effluent is presented in Section 7.1.6.2. All points or areas of discharge are located on USFS land; however, Sardine Meadow (discharge option 2) is outside of the mine site. Passive treatment of metals is used primarily to eliminate exposure to and mobility of contaminants in waters from the mine site. Shipping the ZVI and concentrated uranium to an off-site milling facility would control exposure to and mobility of contaminants in precipitate. The recycling of the concentrated uranium eliminates the potential health risk that may be associated with exposure to the contaminated media.

The on-site, passive ZVI reactor system would be comprised of a diversion structure at the outlet of the Pit Creek sediment detention basin (for Alternatives 3, 4 and 5; see Figure 8-4) or the repository under drain (Alternative 6, see Figure 8-4), diversion piping, and gravity fed ZVI reactors. The diversion structure would allow low to moderate creek flows and all of the under drain flow to enter the ZVI reactor. Stormwater flows in excess of design flow (20 gallon per minute) would be allowed to overflow into Pit Creek, as the combined storm water and baseflow would meet discharge standards above the design flow. A treatability study will be required prior to design to assess ZVI reactor hydraulic residence time required for metals reduction and precipitation, ZVI consumption before replacement, metals removal rate, effluent soluble iron concentration, and quantity of metals precipitate generated.

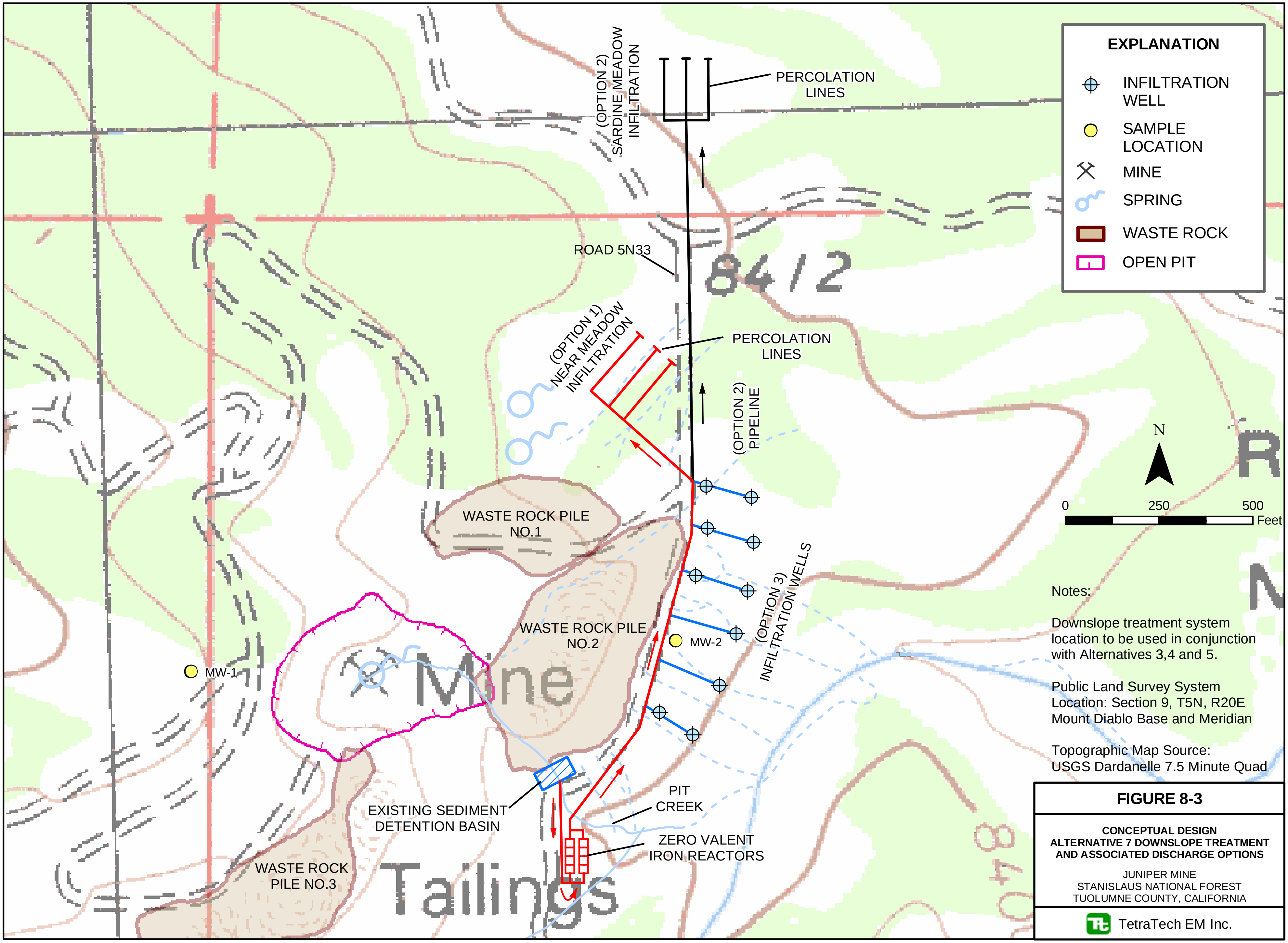


FIGURE 8-3

CONCEPTUAL DESIGN ALTERNATIVE 7 DOWNSLOPE TREATMENT AND ASSOCIATED DISCHARGE OPTIONS

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

TetraTech EM Inc.

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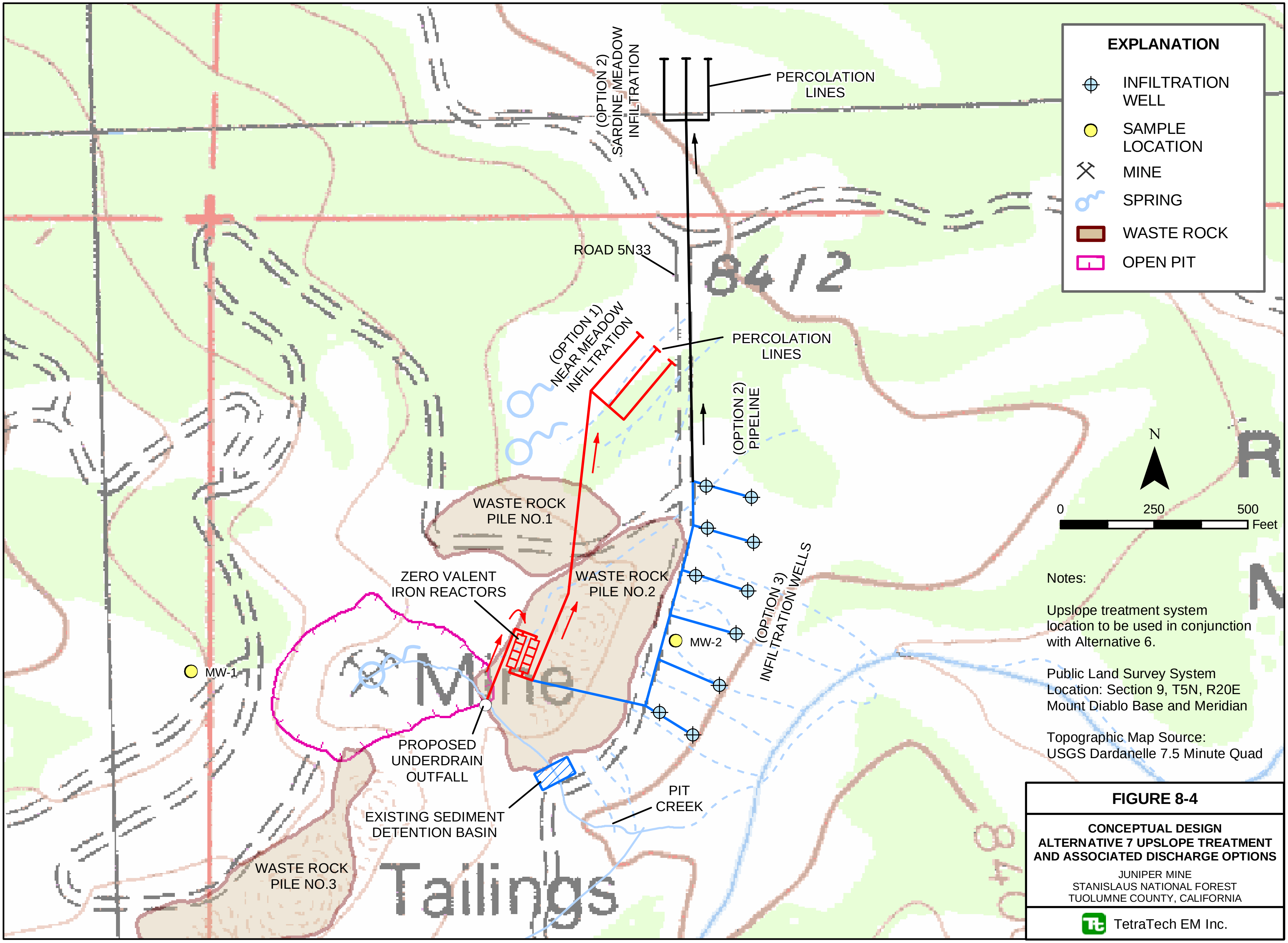

FIGURE 8-4

CONCEPTUAL DESIGN ALTERNATIVE 7 UPSLOPE TREATMENT AND ASSOCIATED DISCHARGE OPTIONS

JUNIPER MINE
STANISLAUS NATIONAL FOREST
TUOLUMNE COUNTY, CALIFORNIA

TetraTech EM Inc.

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The steps for constructing and operating the on-site, passive ZVI reactor system include the following: (1) constructing a flow diversion structure at the outlet of the Pit Creek sediment detention basin and/or a diversion structure at the repository under drain, (2) constructing a diversion pipeline, (3) constructing below grade ZVI reactors, (4) construction of a discharge pipeline and surface water outfall, groundwater percolation system, or infiltration well gallery, (5) removal and disposal of ZVI after 5 years of treatment, (6) revegetating any area disturbed by construction, and (7) shipping of ZVI-uranium precipitate to an off-site milling facility.

Monitoring of system effluent is required to document treatment effectiveness and attainment of PRAGs. Samples will be analyzed for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead. The treatment system is assumed to be necessary for 5 years after which time leachate is no longer expected to be generated. The treatment process will generate a ZVI-uranium solid that will be pumped from the reactor after the 5-year treatment period and shipped to an off-site milling facility. Institutional controls would be used to limit access to the treatment system through the application of access restrictions and limit potential use of surface water and/or groundwater if federal MCLs or background water quality in close proximity to the ore body cannot be attained. Waste- and source-specific process options are described below.

Water Diversion for Treatment in Support of Alternatives 3, 4, or 5.

- The treatment system will be located down gradient of the Pit Creek sediment detention basin.
- A tee fitting will be installed at the outfall of the Pit Creek sediment detention basin. The top of the tee will allow overflow to continue down Pit Creek during high runoff events, while the bottom of the tee will be fitted with a gate valve to control flow going to the treatment system.
- Water will be conveyed in a 200-foot long pipeline between the sediment detention basin outfall and the treatment system.

Water Diversion for Treatment in Support of Alternative 6.

- The treatment system will be located down gradient of the repository under drain at the location of the former Waste Rock Pile No. 2.
- A tee will be installed on the under drain discharge pipe. The top of the tee will allow overflow if groundwater discharge exceeds treatment capacity. The bottom of the tee will be fitted with a gate valve to control flow to the treatment system.
- Water will be conveyed in a 200-foot long pipeline between the under drain outfall and the treatment system.

ZVI Reactor System Configuration in Support of Treatment to Background Groundwater Quality (Alternative 7a).

- A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards. Water will be treated to metal and radionuclide groundwater background levels.

- A flow rate of 20 gpm will be treated in six 2,000-gallon ZVI reactors placed in two independent series configurations. Each reactor will consist of 20 tons of zero valence iron contained in a below grade concrete vault. Water will pass through each vault in an up flow configuration.

- The treatment system will be operate for up to 5 years after which time leachate is no longer expected to be generated.

- At the end of the 5 year operational period, all of the 120 tons of uranium-containing iron in the six reactors will require disposal. Disposal will require pumping the spent iron out of each reactor, transportation to a processing facility, and recovery of uranium from the spent iron.

- Two inspection and monitoring visits will be required during each year of operation, during which time system discharge samples will be collected to verify attainment of discharge standards (metals and isotopes of uranium, thorium, radium, and lead). Water will be treated to metal and radionuclide groundwater background levels.

ZVI Reactor System Configuration in Support of Treatment to Federal MCLs (Alternative 7b).

- A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards. Water will be treated to metal and radionuclide federal MCLs.

- A flow rate of 20 gpm will be treated in eight 2,000-gallon ZVI reactors placed in two independent series configurations. Each reactor will consist of 20 tons of zero valence iron contained in a below grade concrete vault. Water will pass through each vault in an up flow configuration.

- The treatment system will be operate for up to 5 years after which time leachate is no longer expected to be generated.

- At the end of the 5 year operational period, all of the 160 tons of uranium-containing iron in the six reactors will require disposal. Disposal will require pumping the spent iron out of each reactor, transportation to a processing facility, and recovery of uranium from the spent iron.

- Two inspection and monitoring visits will be required during each year of operation, during which time system discharge samples will be collected to verify attainment of discharge standards (metals and isotopes of uranium, thorium, radium, and lead). Water will be treated to metal and radionuclide federal MCLs.

Treated Water Discharge Option 1: Percolation into Near Meadow.

- Water will be conveyed in a 750-foot long, 12-inch diameter HDPE pipeline from the treatment system to Near Meadow located north of existing Waste Rock Pile No.1.

- Flow in the pipeline will be divided into three 200-foot lengths of 4-inch perforated pipe at Near Meadow. The perforated pipe will be buried 8 feet below ground surface with 4 feet of 3/4- inch gravel laid above the pipe and 4 feet of 3/4- inch gravel laid below the pipe.

Treated Water Discharge Option 2: Percolation into Sardine Meadow.

- Water will be conveyed in a 1,600-foot long, 12-inch diameter HDPE pipeline from the treatment system to Sardine Meadow located north of Forest Road 5N01.

- Flow in the pipeline will be divided into three 200-foot lengths of 4-inch perforated pipe at Near Meadow. The perforated pipe will be buried 8 feet below ground surface with 4 feet of 3/4- inch gravel laid above the pipe and 4 feet of 3/4- inch gravel laid below the pipe.

Treated Water Discharge Option 3: Discharge into an Infiltration Well Gallery.

- Water will be conveyed in a 500-foot long, 12-inch diameter HDPE pipeline from the treatment system to the outwash area below existing Waste Rock Pile No.2.

- Water will be diverted from the pipeline at up to six points to feed no more than ten 4-inch diameter infiltration wells. Each infiltration well will be advanced into tuff material to a depth of no more than 100 feet. The formation around each infiltration well will be hydrofractured to improve effluent infiltration rate into the tuff material.

8.7.1 Effectiveness

The implementation of this alternative in conjunction with Alternatives 3 through 6 would reduce the toxicity, mobility, and volume of COCs in surface water, leachate, and/or groundwater discharging to Pit Creek to an extent that would result in an overall risk reduction from all pathways and routes of exposure. The threat of human and ecological exposure due to ingestion of surface water, leachate, and/or groundwater would be controlled through treatment using a ZVI reactor. Shipping the spent iron from the ZVI reactor, which contains concentrated uranium, to an off-site milling facility would control exposure to and mobility of contaminants in precipitate. The recycling of the spent iron containing concentrated uranium eliminates the potential health risk that may be associated with exposure to the contaminated media. Therefore, Alternative 7 is considered to be highly effective for achieving PRAOs for surface water and groundwater.

The effectiveness of this alternative would depend on the concentration of metals in water, flow, pH, suspended solids in, and oxidation state of the influent water. Reactor hydraulic residence time and influent flow will be stabilized through the use of the existing sediment detention basin and a high flow inlet restriction.

Treatment of surface water and/or leachate collected as described in Alternatives 3 through 6 would meet federal and state contaminant-specific ARARs. Pit and Red Rock creeks are fed by groundwater that exceeds water quality standards and applicable benchmarks due to natural contact with the native ore body. Treatment of naturally occurring levels of chemicals in groundwater to a more stringent benchmark or standard is prohibited under CERCLA 104(a)(3)(A). Therefore, under Alternative 7a any residual chemicals in ZVI system effluent discharging to groundwater in Near Meadow (discharge option 1), Sardine Meadow (discharge option 2), or an infiltration well gallery (discharge option 3) will be groundwater background concentrations in close proximity to the ore body. Additional sampling of local groundwater may be necessary to refine the target concentrations of metals and radionuclides discharging from the treatment system. If the treatment system discharges to Pit Creek (Alternative 7b), a surface water body, then treatment to MCLs will be necessary because the CWA supersedes CERCLA 104(a)(3)(A).

The method of effluent discharge includes release to Pit Creek, percolation to shallow groundwater, and infiltration into shallow groundwater. Discharge of effluent to shallow groundwater is protective of human health and ecological receptors because the effluent would be treated to local background concentrations and the effluent is isolated from receptors. A residual risk would remain, though at a level equivalent to that posed by local groundwater. Discharge of effluent to Pit Creek offers the greatest protection to human health and ecological receptors as treatment to federal MCLs would be required prior to discharge. However, treatment to federal MCLs would treat water to concentrations lower than local background concentrations, is more difficult, and would require a larger treatment system. Either route of effluent discharge would comply with chemical-specific ARARs.

The method and location of effluent discharge to groundwater includes: percolation into Near Meadow (discharge option 1), percolation into Sardine Meadow (discharge option 2), and discharge into an infiltration well gallery (discharge option 3). All three methods of discharge to groundwater are protective of human health and ecological receptors; however, infiltration of effluent directly to groundwater (option3) offers a higher degree of protection than percolation (options 1 and 2) as the percolating water may reach the ground surface during the spring snow melt. However, the long term permanence of shallow infiltration wells may be of concern given the potential for biofouling of well screens, plugging of the tight formation with suspended solids in the treatment system effluent, and potential freezing of shallow wellhead inlet piping. Additional maintenance of the shallow infiltration wells would be required to ensure permanence in comparison to simple percolation to groundwater.

Discharge of effluent to shallow groundwater via infiltration wells may require compliance with EPA's Underground Injection Control Program, unless it can be shown that the shallow water bearing zone is not an existing or potential drinking water aquifer or that the effluent will not degrade an existing or potential drinking water aquifer. Effluent discharge to groundwater via percolation also cannot degrade groundwater quality.

Location-specific ARARs are expected to be met without any conflicts.

The mining wastes, including treatment system effluents, were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. Stormwater generated during treatment system construction activities will be managed in accordance with the CWA. Tuolumne County APCD nuisance dust suppression and control requirements are applicable for construction and earth-moving activities associated with this installation of the treatment system for the control of fugitive dust emissions; these requirements would be met through water application to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Maintenance will not be required once the system has been constructed. Confirmation sampling will be required twice a year to ensure compliance with treatment standards and to verify reduction of radionuclide levels in leachate. After the five year treatment period shipping of all of the ZVI-uranium precipitate to an off-site milling facility would be necessary. In addition, institutional controls would be required to prevent land uses that would compromise system integrity and limit potential use of surface water and/or groundwater if federal MCLs or background water quality in close proximity to the ore body cannot be attained.

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed.

8.7.2 Implementability

This alternative is both technically and administratively feasible, and could be implemented within one field season. The treatment system is assumed to require operation for 5 years, at which time the concentrations of COCs in leachate are expected to no longer exceed local background groundwater conditions. However, the actual duration of treatment would depend on the length of time required to stabilize eroding soils, duration of leachate generation, and/ or stability of COC concentrations in groundwater. Treatment system installation will require conventional construction practices; materials and construction methods are readily available. Equipment, materials, and labor would be available through the local market. The treatment system would require a moderate size area in comparison to the more compact ion exchange system (see Alternative 8). Constructing the treatment system would require the services of a contractor experienced in the proper component installation procedures. A bench scale treatability study will be required to demonstrate the technology effectiveness, assess ZVI reactor hydraulic residence time required for metals reduction and precipitation, ZVI consumption before replacement, effluent soluble iron concentration, and quantity of metals precipitate generated. The treatment system would not remain reliable without proper maintenance. This type of response action alternative could be supplemented in the future with additional treatment systems in series for higher flows or removal efficiency, if required.

8.7.3 Costs

Alternative 7a involves metals removal from groundwater and/or leachate to groundwater background levels using six ZVI reactors and the discharge of treated water to groundwater via percolation or infiltration. The total present worth cost for Alternative 7a is estimated to be $669,250 for discharge option 1 where effluent is piped to a percolation system in the Near Meadow, $682,748 for discharge option 2 where effluent is piped to a percolation system in the Sardine Meadow, and $923,231 for discharge option 3 where effluent is piped to a an infiltration well gallery. Table 8-6a presents a breakdown of the costs associated with implementing Alternative 7a including the various options for discharge of effluent to groundwater. Assumptions used in preparing the cost estimate are provided in Appendix A.

Alternative 7b involves metals removal from groundwater and/or leachate to federal MCLs using eight ZVI reactors and the discharge of effluent to Pit Creek. The total present worth cost for Alternative 7b is $807,699. Table 8-6b presents a breakdown of the costs associated with implementing Alternative 7b

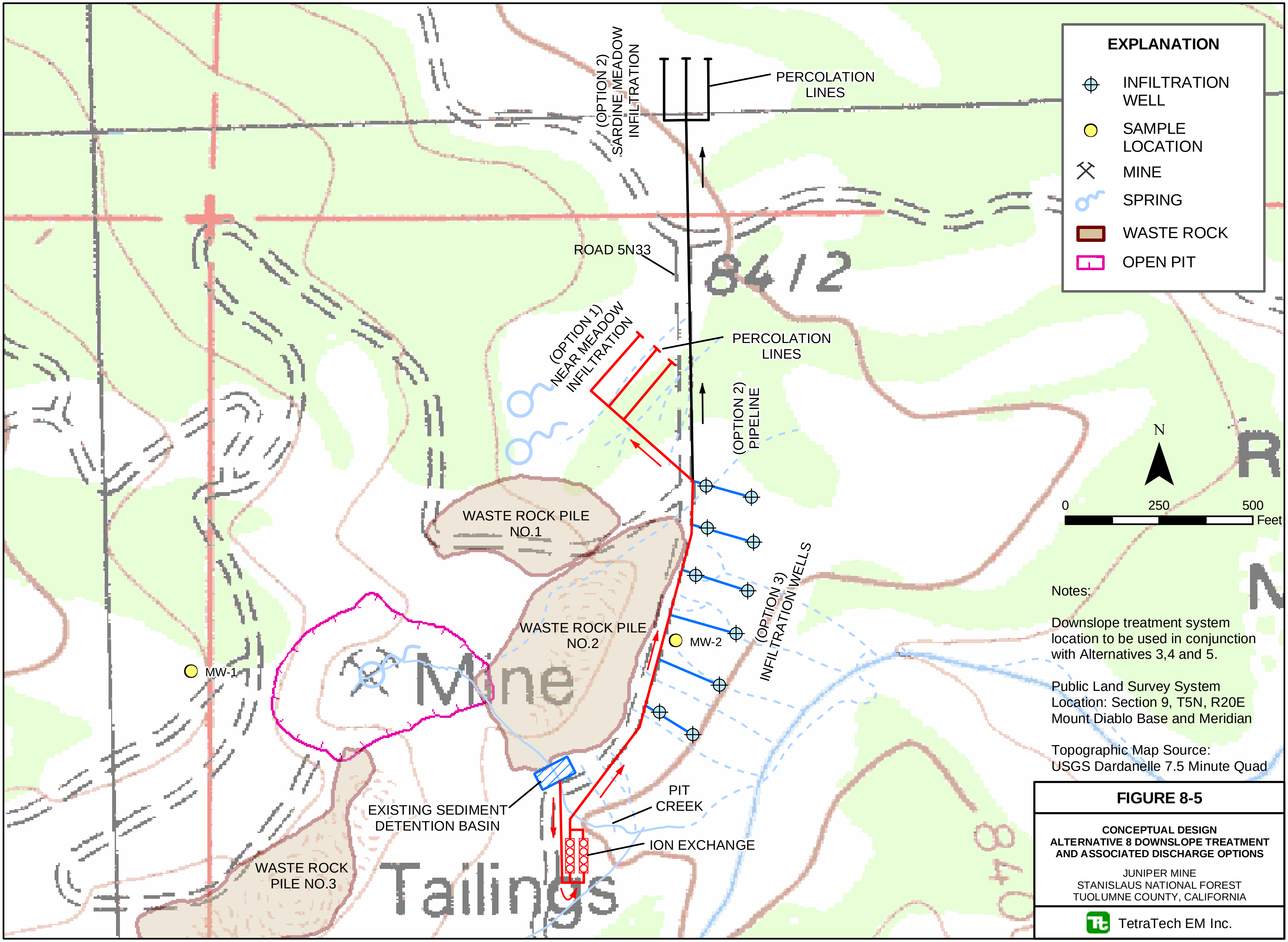
with effluent discharge to Pit Creek. Assumptions used in preparing the cost estimate are provided in Appendix A.

The total present worth cost includes the present value of annual monitoring costs, in addition to the capital costs. Maintenance costs includes two monitoring events per year to verify compliance with ARARs, document attenuation of leachate, and document the need for replacement of ZVI. Zero valence iron is assumed to require replacement every five years unless leachate is no longer being generated. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

8.8 ALTERNATIVE 8: METALS REMOVAL FROM SURFACE WATER, GROUNDWATER, AND LEACHATE USING ION EXCHANGE

Under this alternative, metals and radionuclides in leachate from the waste rock pile toe drains (Alternatives 3, 4, and 5) and from the repository under drain (Alternative 6) would be concentrated on selective ion resin using an on-site, passive ion exchange system. Surface water from Pit Creek may also require treatment if surface controls (Alternatives 3, 4, and 5) are not effective in reducing contaminant migration. Water impacted by mining activities would be treated to background groundwater concentrations (Alternative 8a) or to federal MCLs (Alternative 8b). Under Alternative 8a, water treated to background groundwater concentrations would be percolated into the near meadow using three 200-foot long below grade perforated pipes (discharge option 1), percolated into sardine meadow using three 200-foot long below grade perforated pipes (discharge option 2), or discharged to a gallery of up to ten 100-foot deep infiltration wells (discharge option 3) (see Figures 8-5 and 8-6). Under Alternative 8b, water treated to federal MCLs would be discharged directly into Pit Creek. A description of discharge approaches for treatment system effluent is presented in Section 7.1.6.2. All points or areas of discharge are located on USFS land; however, Sardine Meadow (discharge option 2) is outside of the mine site. Passive treatment of metals is used primarily to eliminate exposure to and mobility of contaminants in waters from the mine site. Spent resin may be regenerated on or off-site. Shipping uranium elutent removed from the selective ion resin during regeneration to an off-site milling facility would control exposure to and mobility of contaminants. The recycling of the resin and concentrated uranium elutent eliminates the potential health risk that may be associated with exposure to the contaminated media.

The on-site, passive ion exchange system would be comprised of a diversion structure at the outlet of the Pit Creek sediment detention basin (Alternatives 3, 4 and 5; see Figure 8-5) or the repository under drain



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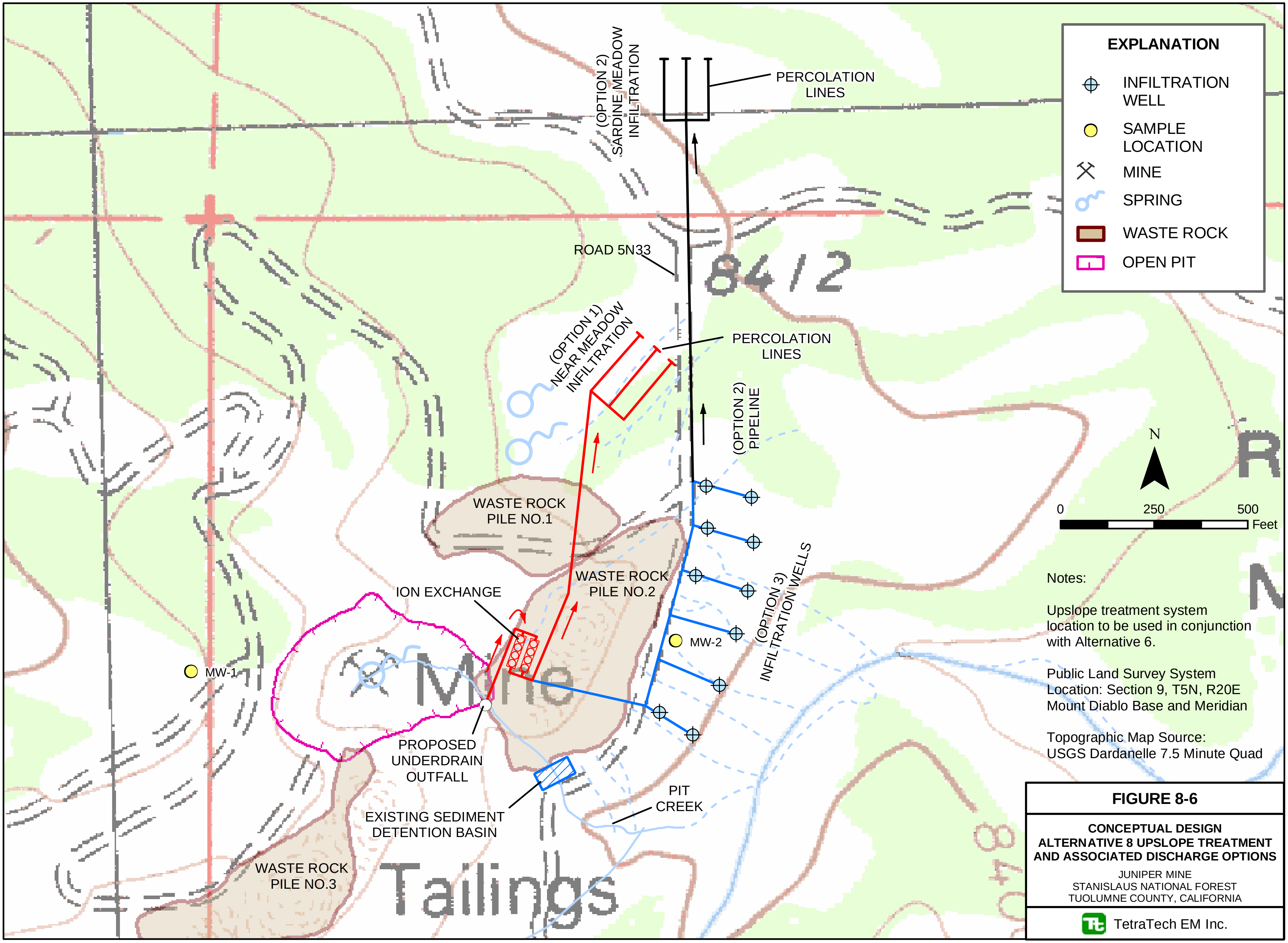

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(Alternative 6, see Figure 8-6), diversion piping, and gravity fed ion exchange beds. The diversion structure would allow low to moderate creek flows and all of the under drain flow to enter the ion exchange system. Stormwater flows in excess of design flow (20 gallon per minute) would be allowed to overflow into Pit Creek, as the combined storm water and baseflow would meet discharge standards above the design flow.

Additional resin beds may be operated in series to more efficiently remove metals and effectively load the beds. Beds may be configured in a lead/lag position (sometimes called a merry-go-round) where a freshly regenerated bed is placed in one "lag" position and partially loaded bed is placed in the "lead" position to maximize the loading on the resin. A bench-scale treatability study will be required prior to design to assess source water specific metals loading rates, optimal resin composition, hydraulic residence time required for ion exchange, time interval before regeneration of resin, metals removal rate, and quantity and concentration of metals in regeneration elutent.

The steps for constructing and operating the on-site, passive ion exchange system include the following: (1) constructing a flow diversion structure at the outlet of the Pit Creek culvert (surface water) and/or a diversion structure at the repository under drain, (2) constructing a diversion pipeline, (3) constructing a below grade equipment vault for the ion exchange beds (winter freezing), (4) construction of a discharge pipeline and surface water outfall, groundwater percolation system, or infiltration well gallery, (5) removal and disposal of ion exchange resin after 5 years of treatment, (6) revegetating any area disturbed by construction, and (7) shipping of ion exchange resin to an off-site regeneration facility and recovery of uranium from elutent at an off-site milling facility.

Monitoring of system effluent is required to document treatment effectiveness and attainment of PRAGs. Samples will be analyzed for metals, total suspended solids, and isotopes of uranium, thorium, radium, and lead. The treatment system is assumed to be necessary for 5 years after which time leachate is no longer expected to be generated. The ion exchange resin would be shipped to an off-site regeneration facility and uranium recovered from the elutent at an off-site processsing facility following the five year treatment period. Institutional controls would be used to limit access to the treatment system through the application of access restrictions and limit potential use of surface water and/or groundwater if federal MCLs or background water quality in close proximity to the ore body cannot be attained. Waste- and source-specific process options are described below.

Water Diversion for Treatment in Support of Alternatives 3, 4, or 5.

- The treatment system will be located down gradient of the Pit Creek sediment detention basin.

- A tee fitting will be installed at the outfall of the Pit Creek sediment detention basin. The top of the tee will allow overflow to continue down Pit Creek during high runoff events, while the bottom of the tee will be fitted with a gate valve to control flow going to the treatment system.

- Water will be conveyed in a 200-foot long pipeline between the sediment detention basin outfall and the treatment system.

Water Diversion for Treatment in Support of Alternative 6.

- The treatment system will be located down gradient of the repository under drain at the location of the former Waste Rock Pile No. 2.

- A tee will be installed on the under drain discharge pipe. The top of the tee will allow overflow if groundwater discharge exceeds treatment capacity. The bottom of the tee will be fitted with a gate valve to control flow to the treatment system.

- Water will be conveyed in a 200-foot long pipeline between the under drain outfall and the treatment system.

Ion Exchange Reactor System Configuration in Support of Treatment to Background Groundwater Quality (Alternative 8a).

- A flow rate of 20 gpm will be treated in eight ion exchange reactors placed in two independent series configurations. Each reactor will consist of 7 tons of ion exchange resin contained in vessel placed in a below grade concrete vault. Water will pass through each reactor in an up flow configuration.

- A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards. Water will be treated to metal and radionuclide groundwater background levels.

- The treatment system will be operate for up to 5 years after which time leachate is no longer expected to be generated.

- At the end of the 5 year operational period, all of the 56 tons of uranium-containing ion exchange resin in the six reactors will require disposal. Disposal will require pumping the spent resin out of each reactor, transportation to a regeneration facility, and processing of elutent to recover uranium.

- Two inspection and monitoring visits will be required during each year of operation, during which time system discharge samples will be collected to verify attainment of discharge standards. Water will be treated to metal and radionuclide groundwater background levels.

Ion Exchange Reactor System Configuration in Support of Treatment to Federal MCLs (Alternative 8b).

- A flow rate of 20 gpm will be treated in eight ion exchange reactors placed in two independent series configurations. Each reactor will consist of 7 tons of ion exchange resin contained in vessel placed in a below grade concrete vault. Water will pass through each reactor in an up flow configuration.

- A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards. Water will be treated to metal and radionuclide federal MCLs.

- The treatment system will be operate for up to 5 years after which time leachate is no longer expected to be generated.

- At the end of the 5 year operational period, all of the 56 tons of uranium-containing ion exchange resin in the six reactors will require disposal. Disposal will require pumping the spent resin out of each reactor, transportation to a regeneration facility, and processing of elutent to recover uranium.

- Two inspection and monitoring visits will be required during each year of operation, during which time system discharge samples will be collected to verify attainment of discharge standards. Water will be treated to metal and radionuclide federal MCLs.

Treated Water Discharge Option 1: Percolation into Near Meadow.

- Water will be conveyed in a 750-foot long, 12-inch diameter HDPE pipeline from the treatment system to Near Meadow located north of existing Waste Rock Pile No.1.

- Flow in the pipeline will be divided into three 200-foot lengths of 4-inch perforated pipe at Near Meadow. The perforated pipe will be buried 8 feet below ground surface with 4 feet of 3/4- inch gravel laid above the pipe and 4 feet of 3/4- inch gravel laid below the pipe.

Treated Water Discharge Option 2: Percolation into Sardine Meadow.

- Water will be conveyed in a 1,600-foot long, 12-inch diameter HDPE pipeline from the treatment system to Sardine Meadow located north of Forest Road 5N01.

- Flow in the pipeline will be divided into three 200-foot lengths of 4-inch perforated pipe at Near Meadow. The perforated pipe will be buried 8 feet below ground surface with 4 feet of 3/4- inch gravel laid above the pipe and 4 feet of 3/4- inch gravel laid below the pipe.

Treated Water Discharge Option 3: Discharge into an Infiltration Well Gallery.

- Water will be conveyed in a 500-foot long, 12-inch diameter HDPE pipeline from the treatment system to the outwash area below existing Waste Rock Pile No.2.

- Water will be diverted from the pipeline at up to six points to feed no more than ten 4-inch diameter infiltration wells. Each infiltration well will be advanced into tuff material to a depth of no more than 100 feet. The formation around each infiltration well will be hydrofractured to improve effluent infiltration rate into the tuff material.

8.8.1 Effectiveness

The implementation of this alternative in conjunction with Alternatives 3 through 6 would reduce the toxicity, mobility, and volume of COCs in surface water, leachate, and/or groundwater discharging from the mine to Pit Creek to an extent that would result in an overall risk reduction from all pathways and routes of exposure. The threat of human and ecological exposure due to ingestion of surface water, leachate, and/or groundwater would be controlled through treatment using ion exchange beds. Spent resin may be regenerated on- or off-site. Shipping uranium elutent removed from the selective ion resin during regeneration to an off-site milling facility would control exposure to and mobility of contaminants. The recycling of the resin and concentrated uranium elutent eliminates the potential health risk that may be associated with exposure to the contaminated media. Therefore, Alternative 8 is considered to be highly effective for achieving PRAOs for surface water and groundwater.

The effectiveness of this alternative would depend on the concentration of metals in water, flow, pH, and the suspended solids in the influent water. Ion exchange bed hydraulic residence time and influent flow will be stabilized through the use of the existing sediment detention basin and a high flow inlet restriction.

Treatment of surface water and/or leachate collected as described in Alternatives 3 through 6 would meet federal and state contaminant-specific ARARs. Pit and Red Rock creeks are fed by groundwater that exceeds water quality standards and applicable benchmarks due to natural contact with the native ore body. Treatment of naturally occurring levels of chemicals in groundwater to a more stringent benchmark or standard is prohibited under CERCLA 104(a)(3)(A). Therefore, under Alternative 8a any residual chemicals in ion exchange system effluent discharging to groundwater in Near Meadow (discharge option 1), Sardine Meadow (discharge option 2), or an infiltration well gallery (discharge option 3) will be groundwater background concentrations in close proximity to the ore body. Additional sampling of local groundwater may be necessary to refine the target concentrations of metals and radionuclides discharging from the treatment system. If the treatment system discharges to Pit Creek (Alternative 8b), a surface water body, then treatment to MCLs will be necessary because the CWA supersedes CERCLA 104(a)(3)(A).

The method of effluent discharge includes release to Pit Creek, percolation to shallow groundwater, and infiltration into shallow groundwater. Discharge of effluent to shallow groundwater is protective of human health and ecological receptors because the effluent would be treated to local background concentrations and the effluent is isolated from receptors. A residual risk would remain, though at a level

equivalent to that posed by local groundwater. Discharge of effluent to Pit Creek offers the greatest protection to human health and ecological receptors as treatment to federal MCLs would be required prior to discharge. However, treatment to federal MCLs would treat water to concentrations lower than local background concentrations, is more difficult, and would require a larger treatment system. Either route of effluent discharge would comply with chemical-specific ARARs.

The method and location of effluent discharge to groundwater includes: percolation into Near Meadow (discharge option 1), percolation into Sardine Meadow (discharge option 2), and discharge into an infiltration well gallery (discharge option 3). All three methods of discharge to groundwater are protective of human health and ecological receptors; however, infiltration of effluent directly to groundwater (option 3) offers a higher degree of protection than percolation (options 1 and 2) as the percolating water may reach the ground surface during the spring snow melt. However, the long term permanence of shallow infiltration wells may be of concern given the potential for biofouling of well screens, plugging of the tight formation with suspended solids in the treatment system effluent, and potential freezing of shallow wellhead inlet piping. Additional maintenance of the shallow infiltration wells would be required to ensure permanence in comparison to simple percolation to groundwater.

Discharge of effluent to shallow groundwater via infiltration wells may require compliance with EPA's Underground Injection Control Program, unless it can be shown that the shallow water bearing zone is not an existing or potential drinking water aquifer or that the effluent will not degrade an existing or potential drinking water aquifer. Effluent discharge to groundwater via percolation also cannot degrade groundwater quality.

Location-specific ARARs are expected to be met without any conflicts.

The mining wastes, including treatment system effluents, were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. Stormwater generated during treatment system construction activities will be managed in accordance with the CWA. Tuolumne County APCD nuisance dust suppression and control requirements are applicable for construction and earth-moving activities associated with this installation of the treatment system for the control of fugitive dust emissions; these requirements would be met through water application to construction or excavation areas, if necessary. OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Maintenance will not be required once the system has been constructed. Confirmation sampling will be required twice a year to ensure compliance with treatment standards and to verify reduction of radionuclide levels in leachate. After the five year treatment period shipping of all of the ion exchange resin to an off-site regeneration and uranium recovery facility would be necessary. In addition, institutional controls would be required to prevent land uses that would compromise system integrity and limit potential use of surface water and/or groundwater if federal MCLs or background water quality in close proximity to the ore body cannot be attained.

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed.

8.8.2 Implementability

This alternative is both technically and administratively feasible, and could be implemented within one field season. The treatment system is assumed to require operation for 5 years, at which time the concentrations of COCs in leachate are expected to no longer exceed local background groundwater conditions. However, the actual duration of treatment would depend on the length of time required to stabilize eroding soils, duration of leachate generation, and/or stability of COC concentrations in groundwater. Treatment system installation will require conventional construction practices; materials and construction methods are readily available. Equipment, materials, and labor would be available through the local market. The treatment system would require a small area in comparison to the ZVI treatment alternative. Constructing the treatment system would require the services of a contractor experienced in the proper component installation procedures. A bench scale treatability study will be required to demonstrate the technology effectiveness, assess source water specific metals loading rates, optimal resin composition, hydraulic residence time required for ion exchange, time interval before regeneration of resin, and quantity and concentration of metals in regeneration elutent. The treatment system would not remain reliable without proper maintenance. This type of response action alternative could be supplemented in the future with additional treatment systems in series for higher flows or removal efficiency, if required.

8.8.3 Costs

Alternative 8a involves metals removal from groundwater and/or leachate to groundwater background levels using six ion exchange reactors and the discharge of treated water to groundwater via percolation or infiltration. The total present worth cost for Alternative 8a is estimated to be $551,530 for discharge option 1 where effluent is piped to a percolation system in the Near Meadow, $565,028 for discharge option 2 where effluent is piped to a percolation system in the Sardine Meadow, and $805,511 for discharge option 3 where effluent is piped to a an infiltration well gallery. Table 8-7a presents a breakdown of the costs associated with implementing Alternative 8a including the various options for discharge of effluent to groundwater. Assumptions used in preparing the cost estimate are provided in Appendix A.

Alternative 8b involves metals removal from groundwater and/or leachate to federal MCLs using eight ion exchange reactors and the discharge of effluent to Pit Creek. The total present worth cost for Alternative 8b is $655,989. Table 8-7b presents a breakdown of the costs associated with implementing Alternative 8b with effluent discharge to Pit Creek. Assumptions used in preparing the cost estimate are provided in Appendix A.

The total present worth cost includes the present value of annual monitoring costs, in addition to the capital costs. Maintenance costs includes two monitoring events per year to verify compliance with ARARs, document attenuation of leachate, and document the need for replacement of ion exchange resin. Ion exchange resin is assumed to require replacement every five years unless leachate is no longer being generated. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

TABLE 8-1
COST ESTIMATE
ALTERNATIVE 2: INSTITUTIONAL CONTROLS
JUNIPER MINE
(Page 1 of 1)

Cost Item	Quantity	Unit	Unit Cost	Cost
Yearly Operation and Maintenance (O&M) Costs				
Fence and Sign Inspections	2.0	EA	500.00	1,000.00
Fence and Sign Maintenance		30% of Original Construction Cost		30,000.00
Subtotal O&M Costs				31,000.00
O&M Contingencies		15 %		4,650.00
Total Yearly O&M Cost				35,650.00
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		146,172.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		442,383.00
Total Present Worth with 5 Years of O&M				181,822.00
Additional Cost of Total Present Worth for O&M for years 6 through 30				296,211.00
Total Present Worth with 30 Years of O&M				478,033.00

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Notes: EA = Each
O&M = Operation and Maintenance
PF = Present Worth Factor
% = Percent

TABLE 8-2
COST ESTIMATE
ALTERNATIVE 3: SURFACE AND INSTITUTIONAL CONTROLS, WATER TREATMENT
JUNIPER MINE
(Page 1 of 1)

Cost Item	Quantity	Unit	Unit Cost	Cost
Capital Costs				
Mobilization, Cleanup and Demobilization	1.0	LS	10,495.00	10,495.00
Site Preparation and Storm Water Control Improvements	11.49	AC	5,304.61	60,950.01
Road Waste Relocation and Consolidation	1,422	CY	3.90	5,545.80
Waste Rock Pile No. 1, 2, and 3 Grading	9.7	AC	1,538.28	14,921.32
Waste Rock Pile Nos. 1 and 2 Toe Stabilization	600	LF	164.00	98,400.00
Waste Rock Pile Nos. 1 and 2 Gully Stabilization	1.0	LS	50,942.96	50,942.96
Drain at Toe of Waste Rock Pile Nos. 1 and 2	1.0	LS	29,904.45	29,904.45
Fertilize, Seed, and Mulch	13.4	AC	2,307.44	30,919.70
Subtotal Construction Costs				302,079.24
Construction Contingencies		15 % of Construction Cost		45,311.89
Engineering Design and Construction Oversight		Estimated		19,200.00
Radiological Screening and Air Monitoring		LS		41,252.18
Total Capital Costs				407,843.30
Yearly Operation and Maintenance (O&M) Costs				
Monitoring	2.0	EA	9,600.00	19,200.00
Site Inspections	2.0	EA	800.00	1,600.00
Site Maintenance		5% of Construction Cost		15,103.96
Subtotal O&M Costs				35,903.96
O&M Contingencies		15 %		5,385.93
Total Yearly O&M Cost				41,289.56
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		169,295.89
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		512,365.88
Total Present Worth Based on 5 Years of O&M				577,139.19
Additional Cost of Total Present Worth for O&M for years 6 through 30				343,069.99
Total Present Worth Based on 30 Years of O&M				920,209.18

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Additional water treatment costs are provided in Tables 8-6a, 8-6b, 8-7a and 8-7b for leachate intercepted in the drains along the toes of Waste Rock Pile Nos. 1 and 2 and for surface water discharging from the mine pit when surface controls within the mine pit are not effective in reducing contaminant migration.

Notes: LS = Lump sum AC = Acre EA = Each LF = Lineal feet
PF = Present Worth Factor % = Percent O&M = Operation and Maintenance

TABLE 8-3
COST ESTIMATE
ALTERNATIVE 4: WASTE ROCK AND SEDIMENT CONSOLIDATION, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE
(Page 1 of 1)

Cost Item	Quantity	Unit	Unit Cost	Cost
Capital Costs				
Mobilization, Cleanup, and Demobilization	1.0	LS	20,000.00	20,000.00
Site Preparation and Storm Water Control Improvements	11.49	AC	5,304.61	60,950.01
Road grading and destruction	1,100	LF	5.45	6,000.00
Road Waste Relocation and Consolidation	1,422	CY	3.90	5,545.80
Waste Rock and Sediment Hotspot Excavation and Consolidation on Waste Rock Pile No. 2	26,348	CY	3.90	102,757.20
Waste Rock Piles Nos. 1, 2, and 3 Grading	9.7	AC	1,538.28	14,921.32
Waste Rock Pile No. 2 Toe Stabilization	200	LF	164.00	32,800.00
Waste Rock Pile No. 2 Gully Stabilization	1.0	LS	44,144.96	44,144.96
Drain at Toe of Waste Rock Pile No. 2	1.0	LS	23,009.26	23,009.26
Fertilize, Seed, and Mulch	13.4	AC	2,307.44	30,919.70
Subtotal Construction Costs				341,048.25
Construction Contingencies		15 % of Construction Cost		51,157.24
Engineering Design and Construction Oversight		Estimated		41,600.00
Radiological Screening and Air Monitoring		LS		55,002.90
Total Capital Costs				488,808.38
Yearly Operation and Maintenance (O&M) Costs				
Monitoring	2.0	EA	9,600.00	19,200.00
Site Inspections	2.0	EA	800.00	1,600.00
Site Maintenance		5% of Construction Cost		17,052.41
Subtotal O&M Costs				37,852.41
O&M Contingencies		15 %		5,677.86
Total Yearly O&M Cost				43,530.27
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		178,481.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		540,163.00
Total Present Worth with 5 Years of O&M				667,289.38
Additional Cost of Total Present Worth for O&M for years 6 through 30				361,682.00
Total Present Worth with 30 Years of O&M				1,028,971.38

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Additional water treatment costs are provided in Tables 8-6a, 8-6b, 8-7a and 8-7b are for leachate intercepted in the drain along the toe of Waste Rock Pile No. 2 and for surface water discharging from the mine pit when surface controls within the mine pit are not effective in reducing contaminant migration.

Notes:
LS = Lump Sum; AC = Acre; EA = Each; LF = Lineal Feet
PF = Present Worth Factor; CY = Cubic yard; % = Percent
O&M = Operation and Maintenance

TABLE 8-4
COST ESTIMATE
ALTERNATIVE 5: WASTE ROCK AND SEDIMENT CONSOLIDATION, EARTHEN COVER WITH GEOMEMBRANE LINER, SLURRY WALL, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Cost Item	Quantity	Unit	Unit Cost	Cost
Capital Costs				
Mobilization, Cleanup, and Demobilization	1.0	LS	25,000.00	25,000.00
Site Preparation and Storm Water Control Improvements	11.49	AC	5,304.61	60,950.00
Road Improvement (Haul and Access)	1,000	LF	3.90	3,900.00
Construct and Decommission Access Road	1,100	LF	5.45	6,000.00
Waste Rock Pile No. 2 Toe Stabilization	200	LF	164.00	32,800.00
Waste Rock Pile No. 2 Gully Stabilization	1.0	LS	44,144.96	44,144.96
Slurry Wall above Waste Rock Pile No. 2	9,000	SF	43.49	391,486.67
Drain at Toe of Waste Rock Pile No. 2	1.0	LS	23,009.26	23,009.26
Waste Rock and Sediment Hotspot Excavation and Consolidation on Waste Rock Pile No. 2	27,770	CY	3.90	108,303.00
Geomembrane and Sand on Consolidated Waste Rock	222,810	SF	2.54	565,937.40
Cover of Waste Rock Pile No. 3 over Consolidated Waste Rock Piles Nos. 1 and 2	22,506	CY	3.90	87,773.40
Waste Rock Piles Nos. 1, 2, and 3 Grading	9.7	AC	1,538.28	14,921.32
Fertilize, Seed, and Mulch	13.4	AC	2,307.44	30,919.70
Subtotal Construction Costs				1,395,145.71
Construction Contingencies		15 % of Construction Cost		209,271.86
Engineering Design and Construction Oversight		Estimated		120,000.00
Radiological Screening and Air Monitoring		LS		110,005.80
Total Capital Costs				1,834,423.36
Yearly Operation and Maintenance (O&M) Costs				
Monitoring	2.0	EA	9,600.00	19,200.00
Site Inspections	2.0	EA	800.00	1,600.00
Site Maintenance		1% of Construction Cost		13,951.46
Subtotal O&M Costs				34,751.46
O&M Contingencies		15 %		5,212.72
Total Yearly O&M Cost				39,964.18
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		163,860.64
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		495,918.64
Total Present Worth with 5 Years of O&M				1,998,284.00
Additional Cost of Total Present Worth for O&M for years 6 through 30				332,058.00
Total Present Worth with 30 Years of O&M				2,330,342.00

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Additional water treatment costs are provided in Tables 8-6a, 8-6b, 8-7a and 8-7b for surface water discharging from the mine pit when surface controls within the mine pit are not effective in reducing contaminant migration.

Notes:

LS = Lump Sum	AC = Acre	EA = Each
SY = Square Yard	LF = Lineal Feet	PF = Present Worth Factor
% = Percent	O&M = Operation and Maintenance	

TABLE 8-5
COST ESTIMATE
ALTERNATIVE 6: WASTE ROCK AND SEDIMENT CONSOLIDATION IN AN ENGINEERED GROUP A MINE WASTE REPOSITORY WITHIN THE PIT, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE
(Page 1 of 1)

Cost Item	Quantity	Unit	Unit Cost	Cost
Capital Costs				
Phase I and II: Mobilization, Cleanup and Demobilization	2.0	LS	25,000.00	50,000.00
Site Preparation and Storm Water Control	11.49	AC	6,629.82	76,176.67
Road Improvement (Haul and Access)	12,000	SF	0.33	3,960.00
Construct and Decommission Access Road	1,100	LF	5.45	6,000.00
Repository Underdrain	1.0	LS	164,513.56	164,513.56
Waste Rock and Sediment Hotspot Excavation, Hauling, and Compaction in Repository	195,143	CY	3.73	727,883.39
Geomembrane Repository Cover and Geomembrane/ Drainage Fabric for Sidewalls	241,941	SF	1.68	406,460.88
Repository Cover Soil (Use a Portion of Waste Rock Pile No. 3 for Cover Soil)	18,876	CY	3.70	69,841.20
Final Site Grading	12.6	AC	1,538.28	19,382.33
Fertilize, Seed, and Mulch	15.6	AC	2,307.44	35,996.06
Subtotal Construction Costs				1,560,214.09
Construction Contingencies		15 % of Construction Cost		234,032.11
Engineering Design and Construction Oversight		Estimated		220,000.00
Radiological Screening and Air Monitoring		LS		201,619.00
Total Capital Costs				2,215,865.21
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	2.0	EA	800.00	1,600.00
Monitoring	2.0	EA	9,600.00	19,200.00
Site Maintenance		1% of Construction Cost		15,602.14
Subtotal O&M Costs				36,402.14
O&M Contingencies		15 %		5,460.32
Total Yearly O&M Cost				41,862.46
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		171,644.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		519,500.00
Total Present Worth with 5 Years of O&M				2,387,509.21
Additional Cost of Total Present Worth for O&M for years 6 through 30				347,856.00
Total Present Worth with 30 Years of O&M				2,735,365.21

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Additional water treatment costs are provided in Tables 8-6a, 8-6b, 8-7a and 8-7b for treatment of both leachate discharging from the repository leachate collection system and groundwater discharging from the French drain beneath the repository.

Notes:

LS = Lump sum	AC = Acre	EA = Each
SF = Square feet	LF = Lineal feet	PF = Present Worth Factor
% = Percent	O&M = Operation and Maintenance	CY = Cubic yard

TABLE 8-6a
COST ESTIMATE
ALTERNATIVE 7a: METALS REMOVAL FROM GROUNDWATER AND LEACHATE TO GROUNDWATER BACKGROUND LEVELS USING ZERO VALENCE IRON
JUNIPER MINE

Cost Item	Quantity	Unit	Unit Cost	Option 1 Cost Treatment and Infiltration of Effluent at Near Meadow	Option 2 Cost Treatment and Infiltration of Effluent at Sardine Meadow	Option 3 Cost Treatment and Infiltration of Effluent at Infiltration Well Gallery
Capital Costs						
Mobilization, Cleanup and Demobilization	1.0	LS	7,000.00	7,000.00	7,000.00	7,000.00
Diversion Structure	1.0	LS	3,700.00	3,700.00	3,700.00	3,700.00
Pipe from Diversion to Reactor	200	LF	8.80	1,760.00	1,760.00	1,760.00
Treatability Study	1.0	LS	30,000.00	30,000.00	30,000.00	30,000.00
Zero Valence Iron Reactor	6.0	LS	6,300.00	37,800.00	37,800.00	37,800.00
Zero Valence Iron (Cost and Transport)	120	TN	500.00	60,000.00	60,000.00	60,000.00
Revegetation	0.25	AC	2,195.00	548.75	548.75	548.75
Injection Well Installation and Hydrofracturing	10	EA	25,000	0.00	0.00	250,000.00
Effluent Pipe to Near Meadow	750	LF	13.80	10,350.00	0.00	0.00
Effluent Pipe to Sardine Meadow	1,600	LF	13.80	0.00	22,087.00	0.00
Effluent Pipe to Injection Wells	600	LF	13.80	0.00	0.00	8,280.00
Percolation System	600	LF	45.13	27,077.33	27,077.33	0.00
Subtotal Construction Costs				178,236.08	189,973.08	399,088.75
Construction Contingencies		15 % of Construction Cost		26,735.41	28,495.96	59,863.31
Engineering Design and Construction Oversight		Estimated		22,400.00	22,400.00	22,400.00
Disposal Profile	1.0	LS	2,500.00	2,500.00	2,500.00	2,500.00
Iron Removal	6.0	LS	2,000.00	12,000.00	12,000.00	12,000.00
Off-site Uranium Recovery	120	TN	3,500.00	420,000.00	420,000.00	420,000.00
Total Capital Costs				661,871.49	675,369.04	915,852.06
Yearly Operation and Maintenance (O&M) Costs						
Monitoring	2.0	EA	900.00	1,800.00	1,800.00	1,800.00
Total Yearly O&M Cost				1,800.00	1,800.00	1,800.00
Additional 5 Year O&M Cost				494,500.00	494,500.00	494,500.00
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		7,379.00	7,379.00	7,379.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		1,024,180.00	1,024,180.00	1,024,180.00
Total Present Worth with 5 Years of O&M				669,250.49	682,748.04	923,231.06
Total Present Worth with 30 Years of O&M				1,686,051.49	1,699,549.04	1,940,032.06

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Present worth cost for O&M includes two monitoring events per year and zero valence iron removal, disposal and replacement every five years.

Notes:
LS = Lump Sum
AC = Acre
EA = Each
LF = Linear Feet
SY = Square Yard
CY = Cubic yard
PF = Present Worth Factor
% = Percent
TN = Ton
O&M = Operation and Maintenance

TABLE 8-6b
COST ESTIMATE
ALTERNATIVE 7b: METALS REMOVAL FROM GROUNDWATER AND LEACHATE TO SURFACE WATER MCLs USING ZERO VALENCE IRON
JUNIPER MINE

Cost Item	Quantity	Unit	Unit Cost	Treatment and Discharge of Effluent to Pit Creek Cost
Capital Costs				
Mobilization, Cleanup and Demobilization	1.0	LS	7,000.00	7,000.00
Diversion Structure	1.0	LS	3,700.00	3,700.00
Pipe from Diversion to Reactor	200	LF	8.80	1,760.00
Treatability Study	1.0	LS	30,000.00	30,000.00
Zero Valence Iron Reactor	8.0	LS	6,300.00	50,400.00
Zero Valence Iron (Cost and Transport)	160	TN	500.00	80,000.00
Revegetation	0.25	AC	2,195.00	548.75
Subtotal Construction Costs				173,408.75
Construction Contingencies		15 % of Construction Cost		26,011.31
Engineering Design and Construction Oversight		Estimated		22,400.00
Disposal Profile	1.0	LS	2,500.00	2,500.00
Iron Removal	8.0	LS	2,000.00	16,000.00
Off-site Uranium Recovery	160	TN	3,500.00	560,000.00
Total Capital Costs				800,320.06
Yearly Operation and Maintenance (O&M) Costs				
Monitoring	2.0	EA	900.00	1,800.00
Total Yearly O&M Cost				1,800.00
Additional 5 Year O&M Cost				658,500.00
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		7,379.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		1,356,518.00
Total Present Worth with 5 Years of O&M				807,699.06
Total Present Worth with 30 Years of O&M				2,156,838.06

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Present worth cost for O&M includes two monitoring events per year and ZVI removal, disposal and replacement every five years.

Notes:
LS = Lump Sum; AC = Acre; EA = Each; LF = Linear Feet
SY = Square Yard; CY = Cubic yard; PF = Present Worth Factor; % = Percent
TN = Ton; O&M = Operation and Maintenance

TABLE 8-7a
COST ESTIMATE
ALTERNATIVE 8a: METALS REMOVAL FROM GROUNDWATER AND LEACHATE TO GROUNDWATER BACKGROUND LEVELS USING ION EXCHANGE
JUNIPER MINE

Cost Item	Quantity	Unit	Unit Cost	Option 1 Cost Treatment and Infiltration of Effluent at Near Meadow	Option 2 Cost Treatment and Infiltration of Effluent at Sardine Meadow	Option 3 Cost Treatment and Infiltration of Effluent at Infiltration Well Gallery
Capital Costs						
Mobilization, Cleanup and Demobilization	1.0	LS	7,000.00	7,000.00	7,000.00	7,000.00
Diversion Structure	1.0	LS	3,700.00	3,700.00	3,700.00	3,700.00
Pipe from Diversion to Reactor	200	LF	8.80	1,760.00	1,760.00	1,760.00
Treatability Study	1.0	LS	30,000.00	15,000.00	15,000.00	15,000.00
Vault for ion Exchange Vessel	6.0	LS	6,300.00	37,800.00	37,800.00	37,800.00
Ion Exchange Vessel	6	LS	16,261.00	97,566.00	97,566.00	97,566.00
Ion Exchange Resin (Cost and Transport)	42	TN	1,777.00	74,634.00	74,634.00	74,634.00
Revegetation	0.25	AC	2,195.00	548.75	548.75	548.75
Injection Well Installation and Hydrofracturing	10	EA	25,000.00	0.00	0.00	250,000.00
Effluent Pipe to Near Meadow	750	LF	13.80	10,350.00	0.00	0.00
Effluent Pipe to Sardine Meadow	1600	LF	13.80	0.00	22,087.00	0.00
Effluent Pipe to Injection Wells	600	LF	13.80	0.00	0.00	8,280.00
Percolation System	600	LF	45.13	27,077.33	27,077.33	0.00
Subtotal Construction Costs				275,436.08	287,173.08	496,288.75
Construction Contingencies		15 % of Construction Cost		41,315.41	43,075.96	74,443.31
Engineering Design and Construction Oversight		Estimated		22,400.00	22,400.00	22,400.00
Ion Exchange Resin Removal	6	LS	2,000.00	12,000.00	12,000.00	12,000.00
Ion Exchange Resin Regeneration	42	TN	3,500.00	147,000.00	147,000.00	147,000.00
Profile for Resin	1	LS	2,500.00	2,500.00	2,500.00	2,500.00
Off-site Recovery of Uranium from Elutent	1	LS	42,000.00	42,000.00	42,000.00	42,000.00
Profile of Processed Elutent	1	LS	1,500.00	1,500.00	1,500.00	1,500.00
Total Capital Costs				544,151.49	557,649.04	798,132.06
Yearly Operation and Maintenance (O&M) Costs						
Monitoring	2.0	EA	900.00	1,800.00	1,800.00	1,800.00
Total Yearly O&M Cost				1,800.00	1,800.00	1,800.00
Additional 5 Year O&M Cost				279,634.00	279,634.00	279,634.00
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		7,379.00	7,379.00	7,379.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		588,766.00	588,766.00	588,766.00
Total Present Worth with 5 Years of O&M				551,530.49	565,028.04	805,511.06
Total Present Worth with 30 Years of O&M				1,132,917.49	1,146,415.04	1,386,898.06

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Present worth cost for O&M includes two monitoring events per year and ion exchange resin removal, disposal and replacement every five years.

Notes:				
	LS = Lump Sum	AC = Acre	EA = Each	LF = Linear Feet
	SY = Square Yard	CY = Cubic yard	PF = Present Worth Factor	% = Percent
	TN = Ton	O&M = Operation and Maintenance		

TABLE 8-7b
COST ESTIMATE
ALTERNATIVE 8b: METALS REMOVAL FROM GROUNDWATER AND LEACHATE TO SURFACE WATER MCLs USING ION EXCHANGE
JUNIPER MINE

Cost Item	Quantity	Unit	Unit Cost	Treatment and Discharge of Effluent to Pit Creek Cost
Capital Costs				
Mobilization, Cleanup and Demobilization	1.0	LS	7,000.00	7,000.00
Diversion Structure	1.0	LS	3,700.00	3,700.00
Pipe from Diversion to Reactor	200	LF	8.80	1,760.00
Treatability Study	1.0	LS	15,000.00	15,000.00
Vault for Ion Exchange Vessel	8.0	LS	6,300.00	50,400.00
Ion Exchange Vessel	8.0	LS	16,261.00	130,088.00
Ion Exchange Resin (Cost and Transport)	56	TN	1,777.00	99,512.00
Revegetation	0.25	AC	2,195.00	548.75
Subtotal Construction Costs				308,008.75
Construction Contingencies		15 % of Construction Cost		46,201.31
Engineering Design and Construction Oversight		Estimated		22,400.00
Ion Exchange Resin Removal	8	LS	2,000.00	16,000.00
Ion Exchange Resin Regeneration	56	TN	3,500.00	196,000.00
Profile for Resin	1	LS	2,500.00	2,500.00
Off-site Recovery of Uranium from Elutent	1	LS	56,000.00	56,000.00
Profile of Processed Elutent	1	LS	1,500.00	1,500.00
Total Capital Costs				648,610.06
Yearly Operation and Maintenance (O&M) Costs				
Monitoring	2.0	EA	900.00	1,800.00
Total Yearly O&M Cost				1,800.00
Additional 5 Year O&M Cost				371,512.00
Present Worth Based on 5 Years of O&M @ 7.00%		PF Factor = 71.299		7,379.00
Present Worth Based on 30 Years of O&M @ 7.00%		PF Factor = 13.137		774,950.00
Total Present Worth with 5 Years of O&M				655,989.06
Total Present Worth with 30 Years of O&M				1,423,560.06

Assumptions: Unit costs based on professional judgment and recent bids for similar work at the other MEANS estimated abandoned mine reclamation projects.

Present worth cost for O&M includes two monitoring events per year and ion exchange resin removal, disposal and replacement every five years.

Notes: LS = Lump Sum; AC = Acre; EA = Each; SY = Square Yard; CY = Cubic yard; PF = Present Worth Factor; % = Percent; TN = Ton; O&M = Operation and Maintenance

9.0 COMPARATIVE ANALYSIS OF RESPONSE ACTION ALTERNATIVES

This section compares the response action alternatives retained for detailed analysis at Juniper Mine. The comparison focuses on the effectiveness, implementability, and cost of each alternative. The following sections present the comparative analysis, a summary of findings, and the recommended response action based on the comparative analysis.

9.1 COMPARATIVE ANALYSIS

The final step of an EE/CA is to conduct a comparative analysis of the response action alternatives. The analysis will discuss each alternative's relative strengths and weaknesses with respect to each of the criteria, and how reasonably key uncertainties could change expectations of their relative performance. Once completed, the analysis will be used to recommend a response action comprised of one or more of the response action alternatives. A public meeting to present the recommended response action will be conducted and significant oral and written comments will be addressed in writing. The formal selection will be documented in an action memorandum.

The purpose of the analysis is to compare the relative effectiveness, implementability, and cost of the response action alternatives in controlling and reducing the toxicity, mobility, and volume of mine wastes at Juniper Mine. The effectiveness comparison will include consideration of the following criteria: 1) overall protectiveness, 2) compliance with ARARs, 3) long-term effectiveness and permanence, 4) reduction of toxicity, mobility, and volume through treatment, and 5) short-term effectiveness of each alternative. The implementability comparison will include consideration of the following criteria: 1) ability to construct and operate, 2) ease of implementing more action if necessary, 3) availability of services and capacities, and 4) availability of equipment and materials to implement each alternative. The cost comparison will include consideration of the estimated total present worth cost of each alternative.

Each criterion is presented and compared for each response action alternative in Table 9-1. Supporting agency acceptance and community acceptance are additional criteria that will be addressed after the cognizant state agency and the public review the evaluation process and recommended response action alternative.

Comparative Analysis of Alternatives for Solid Media. Baseline conditions at Juniper Mine as represented by Alternative 1, the no action alternative, are not protective of human health and the

environment. Alternative 2 (institutional controls) would inhibit direct human and ecological exposure to contaminants at the mine through existing fencing and signage but would still allow off-site migration of contaminants due to water and wind erosion, radon gas emission, and discharge of contaminated surface water and leachate from the waste rock piles. Trespassers would not be protected by the existing signage and fencing. Therefore, Alternative 2 is not considered protective of human health and the environment. Chemical-specific ARARs would not be met under Alternative 2 because releases of site contaminants to surface water and groundwater would remain unchanged. No ARARs apply to Alternative 1.

Alternatives 3 (surface controls) and 4 (waste consolidation) would reduce contaminant mobility due to water and wind erosion through the use of surface controls. Alternative 4 is more protective than Alternative 3 because consolidation reduces the surface area available for exposure and generation of leachate, wind erosion, and radon gas emission. Similar to Alternative 2, exposure due to ingestion of waste, external irradiation from gamma radiation, and inhalation of radon gas would also be reduced by existing signage and fencing. Both Alternatives 3 and 4 are considered moderately protective of human health and the environment. Alternatives 3 and 4 would comply with ARARs by reducing waste mobility, reducing waste exposure area, isolating contaminated materials from contact with potential receptors using existing fencing and signage, reducing releases of contaminants to surface water, and reducing the potential for leaching of metals into groundwater.

Alternative 5 (consolidation and covering) would inhibit all human and ecological exposure associated with waste rock. Exposure due to ingestion of waste, external irradiation from gamma radiation, and inhalation of radon gas in the mine pit would be reduced by an earthen cover. Alternative 5 is considered more protective of human health and the environment than Alternative 4 because installation of an earthen cover with a geomembrane liner would reduce external irradiation of potential receptors from gamma radiation emitted from waste rock, reduce radon gas emission, and reduce infiltration of water and subsequent generation of leachate. Alternative 6 is considered most protective of human health and the environment because all waste and radiation sources would be consolidated and effectively isolated in an on-site repository. Alternative 5 would comply with ARARs by reducing waste mobility, reducing waste exposure area, containing waste materials, reducing contaminant releases to surface water, and reducing the potential for leaching of metals into groundwater. Alternative 6 would comply with ARARs by isolating waste from the environment.

Comparative Analysis of Alternatives for Water Treatment. Water treatment may be required in conjunction with Alternatives 3 through 6 to reduce the toxicity, mobility, and volume of contaminants in

surface water where 1) surface controls in the mine pit and around the waste rock piles are not effective at reducing contaminant migration, 2) surface water discharging from the mine pit exceeds federal MCLs, or 3) groundwater discharging from waste rock seeps and toes drains or the proposed repository under drain exceeds federal MCLs or local background groundwater quality, depending on the route of discharge.

Alternatives 7 (zero valence iron) and 8 (ion exchange resin) would reduce the discharge of contaminated surface water and leachate from the mine through water treatment. Alternatives 7 and 8 are equally protective of human health and the environment as both technologies have been demonstrated to obtain discharge concentrations below federal MCLs and local background groundwater quality. Alternative 7 may be more protective than Alternative 8 because of the simplicity of design and operation. If either system fails during the winter months, then a release of water to Pit Creek or shallow groundwater may occur. Therefore, given an extremely cold environment and lack of access during long winters for system maintenance the simple, redundant design of a zero valence iron system is favored. Both Alternatives 7 and 8 would comply with ARARs by treating contaminated surface water and groundwater to federal MCLs or local background groundwater quality, depending on the method of effluent discharge.

Comparative Analysis of Options for Discharge of Treated Effluent. Alternatives 7 and 8 have been divided into two subparts in order to evaluate the issues related to treatment of water to groundwater background concentrations (subparts 7a and 8a) or to federal MCLs (subparts 7b and 8b). Under subparts 7a and 8a, water treated to background groundwater concentrations would be percolated into the Near Meadow (discharge option 1), percolated into Sardine Meadow (discharge option 2), or discharged to a gallery of infiltration wells (discharge option 3). Under subparts 7b and 8b, water treated to federal MCLs would be discharged directly into Pit Creek.

Alternative subparts A and B are equally protective of human health and the environment as both technologies have been demonstrated to obtain discharge concentrations below federal MCLs and local background groundwater quality. However, treatment to federal MCLs would treat water to concentrations lower than local background concentrations, is more difficult, and would require a larger treatment system. Discharge to shallow groundwater is generally more protective to human health and the environment as the point of discharge is below ground, isolating effluent from receptors, rather than directly into a creek. Any system upsets would not have an immediate impact on the environment as residual contaminants would be subject to dilution in the much larger volume of shallow groundwater. This advantage is important during the winter months where an extremely cold environment and lack of

access for system maintenance may give rise to inadequate treatment or treatment system failure. Either route of effluent discharge would comply with chemical-specific ARARs.

All three discharge options to groundwater are protective of human health and ecological receptors; however, infiltration of effluent directly to groundwater (option 3) offers a higher degree of protection than percolation (options 1 and 2) as the percolating water may reach the ground surface during the spring snow melt. However, the long term permanence of shallow infiltration wells may be of concern given the potential for biofouling of well screens, plugging of the tight formation with suspended solids in the treatment system effluent, and potential freezing of shallow wellhead inlet piping. Additional maintenance of the shallow infiltration wells would be required to ensure permanence in comparison to simple percolation to groundwater. All points or areas of discharge are located on USFS land; however, Sardine Meadow (discharge option 2) is outside of the mine site. This may be of concern in regard to enforcement of USFS access restrictions and any water use restrictions.

Discharge of effluent to shallow groundwater via infiltration wells may require compliance with EPA's Underground Injection Control Program, unless it can be shown that the shallow water bearing zone is not an existing or potential drinking water aquifer or that the effluent will not degrade an existing or potential drinking water aquifer. Effluent discharge to groundwater via percolation also cannot degrade groundwater quality.

Comparative Analysis of Costs. Alternative 1 is the least expensive alternative at no cost, followed by estimated capital costs for the following alternatives including present worth cost of 30 years of operations and maintenance: Alternative 2 at $478,033; Alternative 3 at $920,209; Alternative 4 at $1,028,971; Alternative 5 at $2,330,342; and Alternative 6 at $2,387,509. While Alternative 6 is the most expensive alternative for solid media, long-term O&M costs associated with treatment of surface water and/or leachate (Alternatives 7 and 8) necessary for protectiveness under Alternatives 3, 4, and 5 indicate that Alternative 6 capital costs may be reasonable when consideration is given to the short amount of time required for leachate to drain from the repository. Treatment of leachate from the repository should not be required beyond a conservative 5 year period.

Alternative 8a (ion exchange treatment) and effluent percolation in Near Meadow (discharge option 1), is the least expensive water treatment alternative at an estimated cost of $551,530 over 5 years or $1,132,917 over 30 years. Alternative 7a (zero valence iron treatment) and effluent discharge to infiltration wells (discharge option 3), is the most expensive water treatment alternative at an estimated

cost of $923,231 over 5 years or $1,940,032 over 30 years. Discharge option 3 (infiltration well gallery) was the least cost effective method for effluent discharge. The cost of either Alternative 7 or 8 over 30 years must be added to the preceding costs for Alternatives 3, 4, and 5 in order to address contaminants in leachate and potentially surface water discharging from the mine pit if surface controls are ineffective. The cost of either Alternative 7 or 8 over 5 years must be added to the preceding costs for Alternative 6 in order to address short-term treatment (up to 5 years) of leachate-impacted groundwater discharging from the repository under drain. These engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2005 dollars). Changes in the cost elements are likely to occur as a result of new information and data collected during the response action design.

9.2 SUMMARY OF FINDINGS

Alternative 6 provides the greatest protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction in mobility, and short-term effectiveness. Alternative 5 also provides a high degree of protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction in mobility, short-term effectiveness, and implementability. However, long-term effectiveness and permanence under Alternative 6 is greater than Alternative 5 because the waste is isolated from the environment. Alternative 6 is also more protective because all exposure pathways have been eliminated, while Alternative 5 relies on existing fencing and signage to reduce exposure to waste in the mine pit.

Alternatives 3 and 4 are moderately protective of human health and the environment, though external irradiation by gamma radiation and radon emission exposure pathways remain. Reduction of contaminant mobility and long-term effectiveness of Alternatives 3 and 4 is considered to be less than Alternative 5 because the waste is not covered, allowing infiltration and leachate generation, and emission of gamma radiation and radon gas. Alternative 4 is more effective than Alternative 3 due to reduction of exposure area available for erosion, leachate generation, and emission of gamma radiation and radon gas.

Alternatives 7 and 8, when required to treat surface water and/or leachate, are both protective of human health and the environment, comply with chemical-specific ARARs, and reduce contaminant mobility and volume. Implementation of Alternative 7 or 8 would be required in conjunction with Alternative 3, 4, and 5 for treatment of leachate. Implementation of Alternative 7 or 8 may also be required to treat surface water when surface control measures in Alternatives 3, 4, or 5 are not effective in controlling contaminant

migration. Implementation of Alternative 7 or 8 may also be required to treat leachate-impacted groundwater discharging from the repository under drain in Alternative 6.

Discharge to shallow groundwater is generally more protective to human health and the environment as the point of discharge is below ground, isolating effluent from receptors, rather than directly into a creek. Either route of effluent discharge would comply with chemical-specific ARARs. All three groundwater discharge options are protective of human health and ecological receptors; however, infiltration of effluent directly to groundwater (option 3) offers a higher degree of protection than percolation (options 1 and 2) as the percolating water may reach the ground surface during the spring snow melt. However, the long term permanence of shallow infiltration wells may be of concern given the potential for biofouling of well screens, plugging of the tight formation with suspended solids in the treatment system effluent, and potential freezing of shallow wellhead inlet piping. Additional maintenance of the shallow infiltration wells would be required to ensure permanence in comparison to simple percolation to groundwater.

Alternatives 1 and 2 would not provide overall protection of human health and the environment because all exposure pathways remain, with Alternative 2 relying on existing administrative access restrictions and maintenance of existing fencing and signage to reduce exposure to waste at the entire site. Neither alternative reduces off-site migration of contaminants.

9.3 RECOMMENDED RESPONSE ACTION

The recommended response action to control exposure to and mobility of contaminants in mine waste and the mine pit at Juniper Mine is excavation of mine waste and consolidation in a repository (Alternative 6) in combination with treatment of groundwater discharging from the under drain using zero valence iron (Alternative 7a), if required. Treatment system effluent would be percolated to groundwater at Near Meadow just north of Waste Rock Pile No.1 (discharge option 1).

Alternative 6 involves excavation of all waste rock and sediment hotspots, hauling, and consolidation in the existing mine pit. The waste rock will be placed in an engineered repository consisting of an under drain to control groundwater and an earthen cover with integral geomembrane liner and drainage layer. Surface controls will be used to direct rainwater and snowmelt away from the earthen cover. Institutional controls will be used to restrict site access to ensure cover integrity and permanence. Metals and radionuclides in groundwater discharging from the repository under drain would be treated to local background groundwater concentrations, if necessary, using zero valence iron under Alternative 7a.

Treated effluent would be discharged to shallow groundwater in the Near Meadow via below grade percolation trenches (discharge option 1). Institutional controls will be used, if necessary, to limit potential use of groundwater if background water quality in close proximity to the ore body cannot be attained.

A total of six response action alternatives for solid media and two response action alternatives for aqueous media were developed, evaluated, and compared. Each alternative was evaluated and compared to three criteria: effectiveness, implementability, and cost. Alternative 6 in combination with Alternative 7a, discharge option 1 was determined to provide the greatest protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction in mobility, and short-term effectiveness. Alternative 6 in combination with Alternative 7a, discharge option 1 is considered most protective of human health and the environment because all wastes would be effectively isolated in an on-site repository and leachate, if generated, would be treated prior to discharge. If water treatment is required, treatment residuals would require transportation and disposal at an off-site facility. Alternative 6 would meet response action objectives and comply with ARARs by isolating waste from the environment. Long-term effectiveness and permanence under Alternative 6 is greater than all other alternatives because the waste is isolated from the environment. However, water treatment may be required to meet ARARs. The response action would be implemented during two field seasons, with O&M activities limited to ensuring success of revegetation efforts and clean out of sediment basins until vegetation is established. O&M activities for the water treatment system would include two monitoring events each year for a period of 5 years. Alternative 6 would be implemented at an estimated cost of $2,387,509, of which $2,215,865 are capital costs and $171,644 are short-term (5 year) O&M costs until vegetation is established. The estimated cost for short-term (5 year) treatment of discharge from the repository under drain is $669,250 (Alternative 7a, discharge option 1). Long-term O&M costs would be reevaluated after 5 years.

Implementation of Alternative 6 in combination with Alternative 7a, discharge option 1 would be phased in over a two-year period to accommodate winter site access constraints. Year 1 activities would involve: completing a biological assessment and identifying any necessary mitigation activities for those areas subject to a response action that are outside of the footprint of mining activities; excavation and construction of the under drain with perforated PVC-piping in the bottom of the mine pit to control groundwater elevation; placement of the repository subgrade, rehabilitation of mine haul roads; excavation, hauling, and placement of waste from Waste Rock Pile Nos. 1 and 2 in the repository; grading of and installing erosion control features along Pit Creek channel from the under drain to the Forest Road

5N33; grading and hydroseeding excavated areas; placement of erosion control structures to reduce migration of sediment off-site during winter, and monitoring of metals and radionuclides in groundwater discharging from the repository under drain. Year 2 activities would involve: excavation, hauling, and placement of sediment from outwash and drainage areas and site roads; placement and grading of a sand layer on top of consolidated waste; placement of a 30-mil flexible geomembrane liner; placement and grading of a sand layer on top of geomembrane liner; excavation, hauling, and placement of approximately 19,000 cubic yards of cover material excavated from Waste Rock Pile No.3; grading the surface of cover material to direct runoff away from repository slopes; installation of lined drainage ditches on the cover to control run off; scarifying, fertilizing, and seeding the cover surface and slopes; grading and hydroseeding of excavated areas; installation of stormwater control features to divert run-on water around repository cover and excavated areas to a sediment detention basin; construction of sediment detention basins, and monitoring of metals and radionuclides in groundwater discharging from the repository under drain.

After review and comparison of the concentrations of radionuclides and metals in groundwater discharging from the repository under drain to local background groundwater concentrations, USFS will determine whether treatment of under drain water is necessary. USFS will construct a zero valence iron water treatment system adjacent to the repository under drain, a conveyance pipeline, and percolation system in Near Meadow in Year 2 if the concentrations of radionuclides and metals pose a threat to human health and the environment.

TABLE 9-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
JUNIPER MINE
(Page 1 of 4)

Assessment Criteria	**Alternative 1** No Action	**Alternative 2** Institutional Controls	**Alternative 3** Surface and Institutional Controls, Water Treatment	**Alternative 4** Waste Rock and Sediment Consolidation, Water Treatment, Surface and Institutional Controls	**Alternative 5** Waste Rock and Sediment Consolidation, Earthen Cover with Geomembrane Liner, Slurry Wall, Surface and Institutional Controls	**Alternative 6** Waste Rock and Sediment Consolidation in an Engineered Group A Mine Waste Repository within the Pit, Surface and Institutional Controls	**Alternative 7** Metals Removal from Surface Water, Groundwater, or Leachate using Zero Valence Iron	**Alternative 8** Metals Removal from Surface Water, Groundwater, or Leachate using Ion Exchange
Overall Protectiveness								
Public Health, Safety, and Welfare	No reduction in risk.	External irradiation reduced through exclusion, all other exposures remain.	Provides protection by reducing the waste mobility to surface water and groundwater and by reducing the risk of airborne exposure to dust. Exposure due to ingestion of waste, external irradiation by gamma radiation from waste rock and the intact ore body, and inhalation of radon gas would remain. Surface water exposure reduced through surface controls. Groundwater exposures will be reduced with concurrent implementation of Alternatives 7 or 8.	Provides additional protection by reducing the exposed area available for surface water erosion, precipitation infiltration and metals leaching to groundwater, wind erosion, external irradiation, and radon gas emission. Exposure due to ingestion of waste, external irradiation by gamma radiation from waste rock and the intact ore body, and inhalation of radon gas would remain. Surface water exposure reduced through surface controls. Groundwater exposures will be reduced with concurrent implementation of Alternatives 7 or 8.	Exposures associated with the waste rock are expected to be eliminated. Exposure associated with external irradiation and radon gas in the mine pit will remain. Surface water and groundwater exposures will be reduced through surface controls and containment. Groundwater exposures will also be reduced with concurrent implementation of Alternatives 7 or 8.	Exposures associated with mine waste and mine pit are expected to be eliminated. Surface water and groundwater contact with mine waste are expected to be greatly reduced or eliminated. Exposure to natural levels of metals in water will not be addressed as directed under CERCLA 104(a)(3)(A). Groundwater exposures will also be reduced with concurrent implementation of Alternatives 7 or 8.	Surface water and groundwater exposures associated with mine waste are expected to be eliminated through treatment. Contamination associated with releases from the mine will be treated to background groundwater levels if discharged to groundwater or to MCLs if discharged to surface water.	Surface water and groundwater exposures associated with mine waste are expected to be eliminated through treatment. Contamination associated with releases from the mine will be treated to background groundwater levels if discharged to groundwater or to MCLs if discharged to surface water.
Environmental Protectiveness	No protection offered.	Ecological exposures expected to be basically unchanged.	Provides protection by reducing the waste mobility to surface water and groundwater and by reducing the risk of airborne exposure to dust. Exposure due to ingestion of waste and external irradiation by gamma radiation from waste rock and the intact ore body remains. Surface water exposure reduced through surface controls. Groundwater exposures will be reduced with concurrent implementation of Alternatives 7 or 8.	Provides additional protection by reducing the exposed area available for surface water erosion, precipitation infiltration and metals leaching to groundwater, wind erosion, and external irradiation. Exposure due to ingestion of waste and external irradiation by gamma radiation from waste rock and the intact ore body remains. Surface water exposure reduced through surface controls. Groundwater exposures will be reduced with concurrent implementation of Alternatives 7 or 8.	Exposures associated with the waste rock are expected to be eliminated. Exposure associated with external irradiation and radon gas in the mine pit will remain. Surface water and groundwater exposures will be reduced through surface controls and containment.	Exposures associated with mine waste and mine pit are expected to be eliminated. Surface water and groundwater contact with mine waste are expected to be greatly reduced or eliminated. Exposure to leachate, if generated, will be reduced through treatment.	Surface water and groundwater exposures associated with mine waste are expected to be eliminated through treatment. Contamination associated with releases from the mine will be treated to background groundwater levels if discharged to groundwater or to MCLs if discharged to surface water.	Surface water and groundwater exposures associated with mine waste are expected to be eliminated through treatment. Contamination associated with releases from the mine will be treated to background groundwater levels if discharged to groundwater or to MCLs if discharged to surface water.
Compliance with ARARs								
Chemical-Specific	None apply.	Chemical-specific ARARs would not be met.	Chemical-specific ARARs would be met through concurrent implementation of Alternatives 7 or 8.	Chemical-specific ARARs would be met through concurrent implementation of Alternatives 7 or 8.	Chemical-specific ARARs would be met through concurrent implementation of Alternatives 7 or 8.	Chemical-specific ARARs would be met through concurrent implementation of Alternatives 7 or 8.	Chemical-specific ARARs would be met.	Chemical-specific ARARs would be met.
Location-Specific	None apply.	Location-specific ARARs are expected to be met.	Location-specific ARARs are expected to be met.	Location-specific ARARs are expected to be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.
Action-Specific	None apply.	None apply.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.

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JUNIPER MINE

Assessment Criteria	**Alternative 1** No Action	**Alternative 2** Institutional Controls	**Alternative 3** Surface and Institutional Controls, Water Treatment	**Alternative 4** Waste Rock and Sediment Consolidation, Water Treatment, Surface and Institutional Controls	**Alternative 5** Waste Rock and Sediment Consolidation, Earthen Cover with Geomembrane Liner, Slurry Wall, Surface and Institutional Controls	**Alternative 6** Waste Rock and Sediment Consolidation in an Engineered Group A Mine Waste Repository within the Pit, Surface and Institutional Controls	**Alternative 7** Metals Removal from Surface Water, Groundwater, or Leachate using Zero Valence Iron	**Alternative 8** Metals Removal from Surface Water, Groundwater, or Leachate using Ion Exchange
Long-Term Effectiveness and Permanence								
Magnitude of Residual Risk	No reduction in COC levels in any environmental media.	No reduction in COC levels in any environmental media.	Ingestion of waste and external irradiation remain as significant risks. COC levels in surface water reduced due to surface controls. COC levels in groundwater reduced due to less infiltration and concurrent treatment of leachate with Alternatives 7 or 8.	Ingestion of waste and external irradiation remain as a significant though somewhat reduced risk. COC levels in surface water reduced due to surface controls. COC levels in groundwater reduced due to less infiltration and concurrent treatment of leachate with Alternatives 7 or 8.	Contaminated materials remain on site. Significant additional risk reduction over Alternative 4 as contaminant mobility in air, surface water and groundwater is reduced. Exposure associated with external irradiation and radon gas in the mine pit will remain. COC levels in groundwater reduced due to less infiltration and concurrent treatment of leachate with Alternatives 7 or 8.	Contaminated materials remain on site. Significant additional risk reduction over Alternative 5 as waste is isolated from receptors and surface water. COC levels in groundwater reduced due to less infiltration and concurrent treatment of leachate with Alternatives 7 or 8.	COCs in water will be treated to local background groundwater concentrations if discharged to groundwater or MCLs if discharged to surface water. Exposure to natural levels of metals in water will not be addressed as directed under CERCLA 104(a)(3)(A).	COCs in water will be treated to local background groundwater concentrations if discharged to groundwater or MCLs if discharged to surface water. Exposure to natural levels of metals in water will not be addressed as directed under CERCLA 104(a)(3)(A).
Adequacy and Reliability of Controls	No controls implemented, no reliability.	Reliability of fencing and signage depends upon long-term maintenance.	Reliability of surface controls and revegetation depends upon long-term maintenance.	Reliability of surface controls and revegetation depends upon long-term maintenance.	Reliability of cover, in part, upon long-term maintenance. Similar reliability as Alternative 4 for mine pit controls.	Reliability of cover dependent, in part, upon long-term maintenance. Slope stability not a concern as waste cell constructed in mine pit.	The treatment system would not remain reliable without the proper maintenance and replenishment of ZVI. Care must be taken to protect piping and beds from freezing.	The treatment system would not remain reliable without the proper maintenance and regeneration of exchange resin. Care must be taken to protect piping and beds from freezing.
Reduction of Toxicity, Mobility, and Volume through Treatment								
Treatment Process Used and Materials Treated	None.	None.	Concurrent implementation of Alternatives 7 or 8 required to address contaminated groundwater. In addition, surface water may require treatment if surface controls are not effective.	Concurrent implementation of Alternatives 7 or 8 required to address contaminated groundwater. In addition, surface water may require treatment if surface controls are not effective.	Concurrent implementation of Alternatives 7 or 8 required to address contaminated groundwater. In addition, surface water may require treatment if surface controls are not effective.	Concurrent implementation of Alternatives 7 or 8 required to address contaminated groundwater.	Metals removed through reduction and precipitation on iron substrate.	Metals removed through surface exchange with cations on ion-specific resins.
Volume of Contaminated Materials Treated	None.	None.	No treatment process.	No treatment process.	No treatment process.	No treatment process.	Metals in surface water and groundwater will be treated up to a design flow of approximately 20 gallon per minute. Storm flows in excess of this rate would meet natural levels in the creek.	Metals in surface water and groundwater will be treated up to a design flow of approximately 20 gallon per minute. Storm flows in excess of this rate would meet natural levels in the creek.
Expected Degree of Reduction	None.	None.	No treatment process.	No treatment process.	No treatment process.	No treatment process.	Waste would be reduced to natural levels in the creek.	Waste would be reduced to natural levels in the creek.
Short-Term Effectiveness								
Protection of Community During Response Action	Not applicable.	Not applicable.	Fugitive dust emissions control may be required during surface control construction.	Fugitive dust emissions control may be required during excavation, on-site hauling, consolidation, and surface control construction.	Fugitive dust emissions control may be required during construction. Increased truck traffic may be a concern during transport of construction material to Juniper Mine.	Fugitive dust emissions control may be required during construction. Increased truck traffic may be a concern during transport of construction material to Juniper Mine.	Fugitive dust emissions control may be required during construction.	Fugitive dust emissions control may be required during construction.

TABLE 9-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
JUNIPER MINE
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Assessment Criteria	**Alternative 1** No Action	**Alternative 2** Institutional Controls	**Alternative 3** Surface and Institutional Controls, Water Treatment	**Alternative 4** Waste Rock and Sediment Consolidation, Water Treatment, Surface and Institutional Controls	**Alternative 5** Waste Rock and Sediment Consolidation, Earthen Cover with Geomembrane Liner, Slurry Wall, Surface and Institutional Controls	**Alternative 6** Waste Rock and Sediment Consolidation in an Engineered Group A Mine Waste Repository within the Pit, Surface and Institutional Controls	**Alternative 7** Metals Removal from Surface Water, Groundwater, or Leachate using Zero Valence Iron	**Alternative 8** Metals Removal from Surface Water, Groundwater, or Leachate using Ion Exchange
Short-Term Effectiveness								
Protection of On-Site Workers During Response Action	Not applicable.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.	Expected to be sufficient. On-site workers must be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures.
Time Until Response Action Objectives are Achieved	Not applicable.	Does not meet all PRAOs.	Potential to meet all PRAOs in one field season through concurrent treatment of groundwater leachate using ZVI or ion exchange. Revegetation may take several years to become established.	Potential to meet all PRAOs in one field season through concurrent treatment of groundwater leachate using ZVI or ion exchange. Revegetation may take several years to become established.	Potential to meet all PRAOs in one field season through concurrent treatment of groundwater leachate using ZVI or ion exchange. Revegetation may take several years to become established.	Meets all PRAOs in two field seasons through concurrent treatment of groundwater leachate using ZVI or ion exchange. Revegetation may take several years to become established.	Meets surface water and/or groundwater PRAOs in one field season for system construction. Duration of treatment would depend on the length of time required to stabilize eroding soils and/ or uranium leaching out of waste material.	Meets surface water and/or groundwater PRAOs in one field season for system construction. Duration of treatment would depend on the length of time required to stabilize eroding soils and/ or uranium leaching out of waste material.
Implementability								
Ability to Construct and Operate	No construction or operation involved	No difficulties anticipated.	No difficulties anticipated.	No difficulties anticipated.	Requires contractor experienced in the proper installation of specialized caps and liners. Equipment operation on steep slopes may be difficult. No other difficulties anticipated.	Requires contractor experienced in the proper construction of repositories. Equipment operation on steep slopes may be difficult. No other difficulties anticipated.	Constructing the treatment system would require the services of a contractor experienced in the proper component installation procedures. A bench scale treatability study would be required to demonstrate effectiveness, assess design parameters, and assess quantity of metals precipitate generated.	Constructing the treatment system would require the services of a contractor experienced in the proper component installation procedures. A bench scale treatability study would be required to demonstrate effectiveness, assess design parameters, and assess the quantity and concentration of metals in regeneration elutent
Ease of Implementing More Action if Necessary	This alternative does not inhibit other actions from taking place at the site.	Easily implemented, if additional action determined to be necessary (surface controls, excavation, consolidation, cover, or capping)	Easily implemented, if additional action determined to be necessary (excavation, consolidation, cover, or capping).	Easily implemented, if additional action determined to be necessary (in place cover or excavation, consolidation, and capping)	Waste materials located under earthen cover with liner not readily accessed without destroying cover. Other site activities outside of containment area easily implemented.	Waste materials located within repository not readily accessed without destroying cover.	Easily implemented, additional treatment systems could be added in series for higher flows or removal efficiency, if required.	Easily implemented, additional treatment systems could be added in series for higher flows or removal efficiency, if required.
Availability of Services and Capacities	Not applicable.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.
Availability of Equipment and Materials	Not applicable.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.
Estimated Total Present Worth Cost Including 30 Years Of O&M	**$0.00**	**$478,033**	**$920,209**	**$1,028,971**	**$2,330,342**	**$2,735,365**	**7a Option 1 $669,250** **7a Option 2 $682,748** **7a Option 3 $923,231** **7b $807,699**	**8a Option 1 $551,530** **8a Option 2 $565,028** **8a Option 3 $805,511** **8b $655,989**

TABLE 9-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
JUNIPER MINE

Notes:

ARAR	Applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of concern
PRAO	Preliminary response action objective
ZVI	Zero valence iron

Alternatives 2 through 6 include present worth cost of 30 years of operations and maintenance.
Alternatives 7 and 8 include present worth cost of 5 years of operations and maintenance.

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APPENDIX A

COST ESTIMATE ASSUMPTIONS

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 2: INSTITUTIONAL CONTROLS
JUNIPER MINE
(Page 1 of 1)

A 5-strand barbed wire fence has already been installed around the perimeter of the mine site.

Warning signs have already been posted around the perimeter of the mine site.

The only activities required are seasonal repair of the fence wire, posts, and stress panels damaged by snow load. During the winter of 2003-2004 approximately 30 percent of the fence was damaged. Less than 10 signs will require replacement on average, primarily due to theft.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 3: SURFACE AND INSTITUTIONAL CONTROLS, WATER TREATMENT
JUNIPER MINE

Assume 600 feet of ditch above pit high wall that drains away to the north of Waste Rock Pile No.1. Assume three 200-foot ditches above Waste Rock Pile Nos.1, 2 and 3 to prevent run-on. Assume a 900-foot ditch around the perimeter of the pit high wall and a 400-foot ditch along the road between Waste Rock Pile Nos. 1 and 2. Sediment discharge from the pit will collect in the existing sediment detention basin at the Pit Creek road crossing. Install an 18-inch culvert under the Forest Service Road at the end of the ditch between Waste Rock Pile Nos. 1 and 2.

Drainage pipe is necessary for the outfall of each upslope waste rock pile perimeter ditch; 200 feet for Waste Rock Pile No.2; 200 feet for Waste Rock Pile No.3; and 300 feet for Waste Rock Pile No.1.

Pit Creek to be routed through a 36-inch diameter by 300 foot long concrete culvert and will discharge below Waste Rock Pile No.2.

Assume 600 feet of toe stabilization where Pit Creek passes through Waste Rock Pile No.2. Gabions will be used to buttress the toe of the slopes.

Assume grading of Waste Rock Pile Nos. 1, 2, and 3 to focus water to a central point that drains into a sediment detention basin for each waste rock pile. Sediment detention basins will collect water from the surface of Waste Rock Pile No.2 and the access road into a 40,000 square feet, 5.21-foot deep basin; water from the surface of Waste Rock Pile No.3 and the area above the south west high wall will collect into 40,000 square feet, 2.9-foot deep basin; water from the surface of Waste Rock Pile No.1 and the area above the northwest high wall will collect into a 40,000 square feet, 2.9-foot deep basin. All basins assume an 8-foot snow pack with 1 inch of water per foot, 1 inch of rain falling on snow and an 80-percent runoff rate.

Assume 200 feet of straw bales in each waste rock pile sediment detention basin to act as a sediment filter in front of the outlet.

Two velocity breaks, one just east of the eastern most pit spring and a second setback about 40 feet from the point where Pit Creek exits between the pit and Waste Rock Pile No.2. These are to be constructed using 16- to 24-inch boulders that will allow a reduction in water velocity and also retain sediment.

The only waste excavated will be that which makes up the access road between Waste Rock Pile No.1 and Waste Rock Pile No.2, assume 400 feet by 12 feet by 8 feet = 1,422 yd^3 that will be spread on Waste Rock Pile No.2. Excavate waste rock comprising the access road from the turnoff to the point where it goes up onto the waste rock and removal of all of the waste rock that the road is on and consolidation on to Waste Rock Pile No.2. After excavation is complete the road will be graded.

Install water bars only on the former access road between Waste Rock Pile Nos.1 and 2 and the mine pit, spaced every 100 feet and 15 feet long.

After Pit Creek is routed through a box culvert, buttress toe of Waste Rock Pile No.2 slope with fill soil and rock and regrade to reduce slope.

Install drains at the toe of Waste Rock Pile No.1 (500 feet long) and Waste Rock Pile No.2 (700 feet long) to capture leachate and route to Pit Creek for potential treatment as described in Alternative 7 and Alternative 8. Assume excavation is approximately 2 feet wide by 5 feet deep.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 3: SURFACE AND INSTITUTIONAL CONTROLS, WATER TREATMENT
JUNIPER MINE

Vegetation or revegetation assumes tops of Waste Rock Pile Nos.1, 2, and 3, the sediment detention basins and accessible portions of the mine pit. Assume hydroseeding with approved seed mix, tackifier-mulch, and fertilizer. Assume installation of four 250-foot long rows of wattles on the surface of former Waste Rock Pile No.1, eight 250-foot wattles on the surface of Waste Rock Pile No.2, seven 200-foot wattles on the surface of Waste Rock Pile No.3.

Assume annual operations and maintenance will be performed consisting of two site inspections during spring runoff and late summer. Inspections will consist of surface control measures, up to 400 feet of berm and ditch repair, reseeding of 2 acres, 16 acres of re-fertilization, clean out of the sediment detention basins and placement of material on top of Waste Rock Pile No.2.

Assume site inspections will be coordinated with necessary water quality monitoring including sampling of: water samples from the two groundwater wells, the toe drain discharges (spring only), and Pit Creek, and a composite sediment sample from the sediment detention basins. Samples will be analyzed for metals, total suspended solids, and isotopes of uranium, thorium, radium and lead.

Assume radiological screening and air monitoring for 3 weeks for all grading activities.

Water treatment assumptions are included in Alternatives 7 and 8.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 4: WASTE ROCK CONSOLIDATION, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Assume 600 feet of ditch above pit high wall that drains away to the north of Waste Rock Pile No.1. Assume three 200-foot ditches above Waste Rock Pile Nos.1, 2 and 3 to prevent run-on. Assume a 900-foot ditch around the perimeter of the pit high wall and a 400-foot ditch along the road between Waste Rock Pile Nos. 1 and 2. Sediment discharge from the pit will collect in the existing sediment detention basin at the Pit Creek road crossing. Install an 18-inch culvert under the Forest Service Road at the end of the ditch between Waste Rock Pile Nos. 1 and 2.

Drainage pipe is necessary for the outfall of each upslope waste rock pile perimeter ditch; 200 feet for Waste Rock Pile No.2; 200 feet for Waste Rock Pile No.3; and 300 feet for Waste Rock Pile No.1.

Pit Creek to be routed through a 36-inch diameter concrete culvert and will discharge below Waste Rock Pile No.2.

Assume 600 feet of toe stabilization where Pit Creek passes through Waste Rock Pile No.2. Gabions will be used to buttress the toe of the slopes.

Assume grading of Waste Rock Pile Nos. 2 and 3, and the excavated area at former Waste Rock Pile No.1 to focus water to a central point that drains into a sediment detention basin for each waste rock pile. Sediment detention basins will collect water from the surface of Waste Rock Pile No.2 and the access road into a 40,000 square feet, 5.21-foot deep basin; water from the surface of Waste Rock Pile No.3 and the area above the south west high wall will collect into 40,000 square feet, 2.9-foot deep basin; water from the surface of the excavated area at former Waste Rock Pile No.1 and the area above the northwest high wall will collect into a 40,000 square feet, 2.9-foot deep basin. All basins assume an 8-foot snow pack with 1 inch of water per foot, 1 inch of rain falling on snow and an 80-percent runoff rate.

Assume 200 feet of straw bales in each waste rock pile sediment detention basin to act as a sediment filter in front of the outlet.

Two velocity breaks, one just east of the eastern most pit spring and a second setback about 40 feet from the point where Pit Creek exits between the pit and Waste Rock Pile No.2. These are to be constructed using 16- to 24-inch boulders that will allow a reduction in water velocity and also retain sediment.

Install a drain at the toe of Waste Rock Pile No.2 (700 feet long) to capture leachate and route to Pit Creek sediment detention basin for potential treatment as described in Alternative 7 and Alternative 8. Assume excavation is 2 feet wide by approximately 5 feet deep.

Excavate 1,422 yd^3 of waste rock comprising the access road from the turnoff to the point where it goes up onto the waste rock and consolidate on Waste Rock Pile No.2. After excavation is complete the road will be graded.

Install water bars only on the former access road between former Waste Rock Pile No.1 and Waste Rock Pile No.2 and the mine pit, spaced every 100 feet and 15 feet long.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 4: WASTE ROCK CONSOLIDATION, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Excavate approximately 25,000 yd^3 of material from Waste Rock Pile No.1. Haul excavated material up to 500 feet to Waste Rock Pile No.2. Place excavated material in up to 1-foot lifts on top of Waste Rock Pile No.2.

Excavate approximately 135 yd^3 of sediment from the three outwash area drainages below Waste Rock Pile No.1. Assume total drainage area is 3,640 square feet (910 feet by 4 feet). Assume that sediment will be excavated to an average depth of 1 foot. Haul excavated sediment up to 300 feet to Waste Rock Pile No.2. Place excavated sediment in up to 1-foot lifts on top of the consolidated material from Waste Rock Pile No.1.

Excavate approximately 210 yd^3 of sediment from the five outwash area drainages below Waste Rock Pile No.2. Assume total drainage area is 5,636 square feet (1,409 feet by 4 feet). Assume that sediment will be excavated to an average depth of 1 foot. Haul excavated sediment up to 1,300 feet to Waste Rock Pile No.2. Place excavated sediment in up to 1-foot lifts on top of the consolidated material from Waste Rock Pile No.1.

Grade approximately 1,100 feet of a 10-foot wide access road from Forest Road 5N33 to the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2. The road will be temporary and will not require an engineered surface.

Excavate approximately 1,600 yd^3 of sediment from the four alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2. Assume each excavation is 2,700 square feet (60 feet by 45 feet). Assume that sediment will be excavated to an average depth of 4 feet. Haul excavated sediment approximately 1,700 feet to Waste Rock Pile No.2. Place excavated sediment in up to 1-foot lifts on top of the consolidated material from Waste Rock Pile No.1.

Finish grade 10,800 square feet of excavated alluvial fan surface perpendicular to slope to control sheet flow. Scarify surface to receive seed and fertilizer. Broadcast fertilizer and seeds on to graded and scarified area to reduce erosion. Distribute mulch to cover seeds and hold moisture. Install one 60-foot long wattle perpendicular to flow over each excavation area to control sheet flow and direct water perpendicular to the slope.

Construct 10 foot long water control bars every 100 feet along the length of the 1,100 access road to control runoff along the road surface and direct water toward the inside edge of the road. Scarify road and broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture.

Construct a 1,100-foot long by 3-foot wide by 1-foot deep interceptor ditch on the upslope side of graded road to control water running on to graded surface. Route ditch flow to a shallow sediment detention basin (20 feet by 80 feet by 3 feet deep) on the Red Rock Creek floodplain. The basin should contain approximately 2 inches of runoff from the 0.65 acre area above the road. The sediment detention basin will be scarified, fertilized, and seeded to increase sediment capture. Fertilizer and seed will also be broadcast on the graded and scarified area to reduce erosion. Mulch will be distributed to cover seeds and hold moisture. Wattles will be installed to control sheet flow and direct water perpendicular to slope.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 4: WASTE ROCK CONSOLIDATION, WATER TREATMENT, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Vegetation or revegetation assumes tops of Waste Rock Pile Nos.2 and 3, the graded area at former Waste Rock Pile No.1, the sediment detention basins, and accessible portions of the mine pit. Assume hydroseeding with approved seed mix, tackifier-mulch, and fertilizer. Assume installation of four 250-foot long rows of wattles on the surface of former Waste Rock Pile No.1, eight 250-foot wattles on the surface of Waste Rock Pile No.2, seven 200-foot wattles on the surface of Waste Rock Pile No.3.

Assume annual operations and maintenance will be performed consisting of two site inspections during spring runoff and late summer. Inspections will consist of surface control measures, up to 400 feet of berm and ditch repair, reseeding of 2 acres, 16 acres of re-fertilization, clean out of the sediment detention basins and placement of material on top of Waste Rock Pile No.2.

Assume site inspections will be coordinated with necessary water quality monitoring including sampling of: water samples from the two groundwater wells, the toe drain discharge (spring only), and Pit Creek, and a composite sediment sample from the sediment detention basins. Samples will be analyzed for metals, total suspended solids, and isotopes of uranium, thorium, radium and lead.

Assume 4 weeks of radiological screening and air monitoring required during construction activities.

Water treatment assumptions are included in Alternatives 7 and 8.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 5: WASTE ROCK CONSOLIDATION, EARTHEN COVER WITH GEOMEMBRANE LINER, SLURRY WALL, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Assume 600 feet of ditch above pit high wall that drains away to the north of Waste Rock Pile No.1. Assume three 200-foot ditches above Waste Rock Pile Nos.1, 2 and 3 to prevent run-on. Assume a 900-foot ditch around the perimeter of the pit high wall and a 400-foot ditch along the road between Waste Rock Pile Nos. 1 and 2. Sediment discharge from the pit will collect in the existing sediment detention basin at the Pit Creek road crossing. Install an 18-inch culvert under the Forest Service Road at the end of the ditch between Waste Rock Pile Nos. 1 and 2.

Drainage pipe is necessary for the outfall of each upslope waste rock pile perimeter ditch; 200 feet for Waste Rock Pile No.2; 200 feet for Waste Rock Pile No.3; and 300 feet for Waste Rock Pile No.1.

Pit Creek to be routed through a 36-inch diameter concrete culvert and will discharge below Waste Rock Pile No.2.

Assume 600 feet of toe stabilization where Pit Creek passes through Waste Rock Pile No.2. Gabions will be used to buttress the toe of the slopes.

Assume grading of Waste Rock Pile Nos. 2 and 3, and the excavated area at former Waste Rock Pile No.1 to focus water to a central point that drains into a sediment detention basin for each waste rock pile. Sediment detention basins will collect water from the surface of Waste Rock Pile No.2 and the access road into a 40,000 square feet, 5.21-foot deep basin; water from the surface of Waste Rock Pile No.3 and the area above the south west high wall will collect into 40,000 square feet, 2.9-foot deep basin; water from the surface of the excavated area at former Waste Rock Pile No.1 and the area above the northwest high wall will collect into a 40,000 square feet, 2.9-foot deep basin. All basins assume an 8-foot snow pack with 1 inch of water per foot, 1 inch of rain falling on snow and an 80-percent runoff rate.

Assume 200 feet of straw bales in each waste rock pile sediment detention basin to act as a sediment filter in front of the outlet.

Two velocity breaks, one just east of the eastern most pit spring and a second setback about 40 feet from the point where Pit Creek exits between the pit and Waste Rock Pile No.2. These are to be constructed using 16- to 24-inch boulders that will allow a reduction in water velocity and also retain sediment.

Install a drain at the toe of Waste Rock Pile No.2 (700 feet long) to capture leachate and route to Pit Creek sediment detention basin for potential treatment as described in Alternative 7 and Alternative 8. Assume excavation is 2 feet wide by approximately 5 feet deep.

Excavate 1,422 yd^3 of waste rock comprising the access road from the turnoff to the point where it goes up onto the waste rock and consolidate on Waste Rock Pile No.2. After excavation is complete the road will be graded.

Install water bars only on the former access road between former Waste Rock Pile No.1 and Waste Rock Pile No.2 and the mine pit, spaced every 100 feet and 15 feet long.

Excavate approximately 25,000 yd^3 of material from Waste Rock Pile No.1. Haul excavated material up to 500 feet to Waste Rock Pile No.2. Place excavated material in up to 1-foot lifts on top of Waste Rock Pile No.2.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 5: WASTE ROCK CONSOLIDATION, EARTHEN COVER WITH GEOMEMBRANE LINER, SLURRY WALL, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Excavate approximately 135 yd^3 of sediment from the three outwash area drainages below Waste Rock Pile No.1. Assume total drainage area is 3,640 square feet (910 feet by 4 feet). Assume that sediment will be excavated to an average depth of 1 foot. Haul excavated sediment up to 300 feet to Waste Rock Pile No.2. Place excavated sediment in up to 1-foot lifts on top of the consolidated material from Waste Rock Pile No.1.

Excavate approximately 210 yd^3 of sediment from the five outwash area drainages below Waste Rock Pile No.2. Assume total drainage area is 5,636 square feet (1,409 feet by 4 feet). Assume that sediment will be excavated to an average depth of 1 foot. Haul excavated sediment up to 1,300 feet to Waste Rock Pile No.2. Place excavated sediment in up to 1-foot lifts on top of the consolidated material from Waste Rock Pile No.1.

Grade approximately 1,100 feet of a 10-foot wide access road from Forest Road 5N33 to the alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2. The road will be temporary and will not require an engineered surface.

Excavate approximately 1,600 yd^3 of sediment from the four alluvial fans at the bottom of the outwash area drainages below Waste Rock Pile No.2. Assume each excavation is 2,700 square feet (60 feet by 45 feet). Assume that sediment will be excavated to an average depth of 4 feet. Haul excavated sediment approximately 1,700 feet to Waste Rock Pile No.2. Place excavated sediment in up to 1-foot lifts on top of the consolidated material from Waste Rock Pile No.1.

Finish grade 10,800 square feet of excavated alluvial fan surface perpendicular to slope to control sheet flow. Scarify surface to receive seed and fertilizer. Broadcast fertilizer and seeds on to graded and scarified area to reduce erosion. Distribute mulch to cover seeds and hold moisture. Install one 60-foot long wattle perpendicular to flow over each excavation area to control sheet flow and direct water perpendicular to the slope.

Construct 10 foot long water control bars every 100 feet along the length of the 1,100 access road to control runoff along the road surface and direct water toward the inside edge of the road. Scarify road and broadcast fertilizer and seed on to graded area to reduce erosion. Distribute mulch to cover seed and hold moisture.

Construct a 1,100-foot long by 3-foot wide by 1-foot deep interceptor ditch on the upslope side of graded road to control water running on to graded surface. Route ditch flow to a shallow sediment detention basin (20 feet by 80 feet by 3 feet deep) on the Red Rock Creek floodplain. The basin should contain approximately 2 inches of runoff from the 0.65 acre area above the road. The sediment detention basin will be scarified, fertilized, and seeded to increase sediment capture. Fertilizer and seed will also be broadcast on the graded and scarified area to reduce erosion. Mulch will be distributed to cover seeds and hold moisture. Wattles will be installed to control sheet flow and direct water perpendicular to slope.

Place 6 inches of sand on top of the consolidated waste, a 30 mil geomembrane liner over the sand, and an additional 6 inches of sand over the liner for drainage.

Excavate, haul, and place approximately 22,500 yd^3 of material from Waste Rock Pile No.3 on top of the covered waste as a final cover.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 5: WASTE ROCK CONSOLIDATION, EARTHEN COVER WITH GEOMEMBRANE LINER, SLURRY WALL, SURFACE AND INSTITUTIONAL CONTROLS
JUNIPER MINE

Construct a 30-foot deep by 2-foot wide by 300-foot long slurry wall up gradient of the Waste Rock Pile No.2 to divert groundwater around the waste, minimizing the generation of leachate. The slurry wall will be keyed 3 feet into the bedrock.

Vegetation or revegetation assumes tops of Waste Rock Pile Nos.2 and 3, the graded area at former Waste Rock Pile No.1, the sediment detention basins, and accessible portions of the mine pit. Assume hydroseeding with approved seed mix, tackifier-mulch, and fertilizer. Assume installation of four 250-foot long rows of wattles on the surface of former Waste Rock Pile No.1, eight 250-foot wattles on the surface of Waste Rock Pile No.2, seven 200-foot wattles on the surface of Waste Rock Pile No.3.

Assume annual operations and maintenance will be performed consisting of two site inspections during spring runoff and late summer. Inspections will consist of surface control measures, up to 400 feet of berm and ditch repair, reseeding of 2 acres, 16 acres of re-fertilization, clean out of the sediment detention basins and placement of material on top of Waste Rock Pile No.2.

Assume site inspections will be coordinated with necessary water quality monitoring including sampling of: water samples from the two groundwater wells, the toe drain discharge (spring only), and Pit Creek, and a composite sediment sample from the sediment detention basins. Samples will be analyzed for metals, total suspended solids, and isotopes of uranium, thorium, radium and lead.

Assume eight weeks of radiological screening and air monitoring required during construction activities.

Water treatment assumptions are included in Alternatives 7 and 8.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 7a: METALS REMOVAL FROM GROUND WATERS AND LEACHATE TO GROUNDWATER BACKGROUND LEVELS USING ZERO VALENCE IRON
JUNIPER MINE

Assume the treatment system will be located down gradient of the Pit Creek sediment detention basin for Alternatives 3, 4 and 5; and just down gradient of the repository underdrain at the location of the former Waste Rock Pile No. 2 for Alternative 6.

For Alternatives 3, 4, and 5 assume that a tee fitting will be installed at the outfall of the Pit Creek sediment detention basin. The top of the tee will allow overflow to continue down Pit Creek during high runoff events, while the bottom of the tee will be fitted with a gate valve to control flow going to the treatment system.

For Alternative 6 assume that a tee will be installed on the underdrain discharge pipe. The top of the tee will allow overflow if groundwater discharge exceeds treatment capacity. The bottom of the tee will be fitted with a gate valve to control flow to the treatment system.

Assume a 200-foot long by 5-foot deep by 2-foot wide excavation for the pipeline between the sediment detention basin or underdrain outfall and the treatment system.

Assume a flow rate of 20 gpm through six 2,000-gallon concrete vault reactors placed in two independent series configurations. Water will be treated to metal and radionuclide groundwater background levels.

Assume each 2,000-gallon vault reactor contains 20 tons of zero valence iron.

A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards.

The treatment system is assumed to be necessary for 5 years after which time leachate is no longer expected to be generated.

Assume that after the treatment system runs for 5 years all of the 120 tons of uranium-containing iron in the six reactors will require disposal.

Disposal assumes processing and recovery of uranium at International Uranium Corporation in Blanding, UT.

Assume radioactive waste shipping/container requirements.

Assume two inspections and monitoring visits annually, during which discharge samples will be collected to verify attainment of discharge standards. Water will be treated to metal and radionuclide groundwater background levels.

Assume no operations and maintenance costs will be incurred.

Assume system will discharge either to Near Meadow (option 1), Sardine Meadow (option 2) or to an infiltration well gallery (option 3).

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 7a: METALS REMOVAL FROM GROUND WATERS AND LEACHATE TO GROUNDWATER BACKGROUND LEVELS USING ZERO VALENCE IRON
JUNIPER MINE

Assume the option 1 pipeline to Near Meadow will be a 750-foot, 12-inch diameter HDPE pipeline buried 8-feet deep.

Assume the option 2 pipeline to Sardine Meadow will be a 1,600-foot 12-inch diameter HDPE pipeline buried 8-feet deep.

Assume the option 3 pipeline to the infiltration well gallery will be a 500-foot 12-inch diameter HDPE pipeline buried 8-feet deep.

Assume the outfall of the effluent pipe, for options 1 and 2, is made up of three 200-foot lengths of 4-inch perforated pipe. The pipe will be buried 8 feet below ground surface with 4 feet of 3/4- inch gravel laid above the pipe and 4 feet of 3/4- inch gravel laid below the pipe. The excavation will be 2 feet wide.

Assume no more than 10 wells will be necessary for the option 3 infiltration well gallery.

Assume infiltration wells are advanced into tuff material to a depth of no more than 100 feet.

Costs for decommissioning of the water treatment plant and/or disposal of reactors and plant equipment are not provided in this cost estimate.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 7b: METALS REMOVAL FROM GROUND WATER AND LEACHATE TO SURFACE WATER MCLs USING ZERO VALENCE IRON
JUNIPER MINE
(Page 1 of 1)

Assume the treatment system will be located along Pit Creek down gradient of the Pit Creek sediment detention basin for Alternatives 3, 4 and 5; and just down gradient of the repository underdrain at the location of the former Waste Rock Pile No. 2 for Alternative 6.

For Alternatives 3, 4, and 5 assume that a tee fitting will be installed at the outfall of the Pit Creek sediment detention basin. The top of the tee will allow overflow to continue down Pit Creek during high runoff events, while the bottom of the tee will be fitted with a gate valve to control flow going to the treatment system.

For Alternative 6 assume that a tee will be installed on the underdrain discharge pipe. The top of the tee will allow overflow if groundwater discharge exceeds treatment capacity. The bottom of the tee will be fitted with a gate valve to control flow to the treatment system.

Assume a 200-foot long by 5-foot deep by 2-foot wide excavation for the pipeline between the sediment detention basin or underdrain outfall and the treatment system.

Assume a flow rate of 20 gpm through eight 2,000-gallon concrete vault reactors placed in two independent series configurations. Water will be treated to metal and radionuclide surface water MCLs.

Assume each 2,000-gallon vault reactor contains 20 tons of zero valence iron.

Assume system will discharge directly to Pit Creek.

A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards.

The treatment system is assumed to be necessary for 5 years after which time leachate is no longer expected to be generated.

Assume that after the treatment system runs for 5 years all of the 160 tons of uranium-containing iron in the eight reactors will require disposal.

Disposal assumes processing and recovery of uranium at International Uranium Corporation in Blanding, UT.

Assume radioactive waste shipping/container requirements.

Assume two inspections and monitoring visits annually, during which discharge samples will be collected to verify attainment of discharge standards. Water will be treated to metal and radionuclide surface water MCLs.

Assume no operations and maintenance costs will be incurred.

Costs for decommissioning of plant and/or disposal of reactors and plant equipment are not provided in this cost estimate.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 8a: METALS REMOVAL FROM GROUND WATERS AND LEACHATE TO GROUNDWATER BACKGROUND LEVELS USING ION EXCHANGE
JUNIPER MINE

Assume the treatment system will be located down gradient of the Pit Creek sediment detention basin for Alternatives 3, 4 and 5; and just down gradient of the repository underdrain at the location of the former Waste Rock Pile No. 2 for Alternative 6.

For Alternatives 3, 4, and 5 assume that a tee fitting will be installed at the outfall of the Pit Creek sediment detention basin. The top of the tee will allow overflow to continue down Pit Creek during high runoff events, while the bottom of the tee will be fitted with a gate valve to control flow going to the treatment system.

For Alternative 6 assume that a tee will be installed on the underdrain discharge pipe. The top of the tee will allow overflow if groundwater discharge exceeds treatment capacity. The bottom of the tee will be fitted with a gate valve to control flow to the treatment system.

Assume a 200-foot long by 5-foot deep by 2-foot wide excavation for the pipeline between the sediment detention basin or underdrain outfall and the treatment system.

A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards.

Assume a flow rate of 20 gpm through six ion exchange vessels. Assume six 7-ton ion exchange vessels are placed in two independent series configurations. Vessels will be placed in below grade vaults. Water will be treated to metal and radionuclide groundwater background levels.

The treatment system is assumed to be necessary for 5 years after which time leachate is no longer expected to be generated.

Assume that after 5 years of treatment all of the 42 tons of uranium-containing ion exchange resin in the six reactors will require disposal.

Assume radioactive waste shipping/containers are required.

Disposal assumes regeneration of spent resin at Lawrence Livermore Labs, Livermore, CA and processing of elutent at International Uranium Corporation in Blanding, UT.

Assume two inspections and monitoring visits annually, during which discharge samples will be collected to verify attainment of discharge standards. Water will be treated to metal and radionuclide groundwater background levels.

Assume no operations and maintenance costs will be incurred.

Assume system will discharge either to Near Meadow (option 1), Sardine Meadow (option 2) or to an infiltration well gallery (option 3).

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 8a: METALS REMOVAL FROM GROUND WATERS AND LEACHATE TO GROUNDWATER BACKGROUND LEVELS USING ION EXCHANGE
JUNIPER MINE

Assume the option 1 pipeline to Near Meadow will be a 750-foot, 12-inch diameter HDPE pipeline buried 8-feet deep.

Assume the option 2 pipeline to Sardine Meadow will be a 1,600-foot 12-inch diameter HDPE pipeline buried 8-feet deep.

Assume the option 3 pipeline to the infiltration well gallery will be a 500-foot 12-inch diameter HDPE pipeline buried 8-feet deep.

Assume the outfall of the effluent pipe, for options 1 and 2, is made up of three 200-foot lengths of 4-inch perforated pipe. The pipe will be buried 8 feet below ground surface with 4 feet of 3/4- inch gravel laid above the pipe and 4 feet of 3/4- inch gravel laid below the pipe. The excavation will be 2 feet wide.

Assume no more than 10 wells will be necessary for the option 3 infiltration well gallery.

Assume infiltration wells are advanced into tuff material to a depth of no more than 100 feet.

Costs for decommissioning of the water treatment plant and/or disposal of reactors and plant equipment are not provided in this cost estimate.

ASSUMPTIONS FOR COST ESTIMATE
ALTERNATIVE 8b: METALS REMOVAL FROM GROUND WATERS AND LEACHATE TO SURFACE WATER MCLs USING USING ION EXCHANGE
JUNIPER MINE
(Page 1 of 1)

Assume the treatment system will be located along Pit Creek down gradient of the Pit Creek sediment detention basin for Alternatives 3, 4 and 5; and just down gradient of the repository underdrain at the location of the former Waste Rock Pile No. 2 for Alternative 6.

For Alternatives 3, 4, and 5 assume that a tee fitting will be installed at the outfall of the Pit Creek sediment detention basin. The top of the tee will allow overflow to continue down Pit Creek during high runoff events, while the bottom of the tee will be fitted with a gate valve to control flow going to the treatment system.

For Alternative 6 assume that a tee will be installed on the underdrain discharge pipe. The top of the tee will allow overflow if groundwater discharge exceeds treatment capacity. The bottom of the tee will be fitted with a gate valve to control flow to the treatment system.

Assume a 200-foot long by 5-foot deep by 2-foot wide excavation for the pipeline between the sediment detention basin or underdrain outfall and the treatment system.

A bench scale treatability study will be required to verify uranium breakthrough time and the number of pore volumes treated prior to exceeding discharge standards.

Assume a flow rate of 20 gpm through eight ion exchange vessels. Assume the eight 7-ton exchange vessels are placed in two independent series configurations. Vessels will be placed in below grade vaults. Water will be treated to metal and radionuclide surface water MCLs.

Assume system will discharge directly to Pit Creek.

Assume radioactive waste shipping/containers are required.

The treatment system is assumed to be necessary for 5 years after which time leachate is no longer expected to be generated.

Assume that after 5 years of treatment all of the 56 tons of uranium-containing ion exchange resin in the eight reactors will require disposal.

Disposal assumes regeneration of spent resin at Lawrence Livermore Labs, Livermore, CA and processing of elutent at International Uranium Corporation in Blanding, UT.

Assume two inspections and monitoring visits annually, during which discharge samples will be collected to verify attainment of discharge standards. Water will be treated to metal and radionuclide surface water MCLs

Assume no operations and maintenance costs will be incurred.

Costs for decommissioning of plant and/or disposal of reactors and plant equipment are not provided in this cost estimate.

APPENDIX B

FIELD NOTES

JUNIPER URANIUM MINE
2002 WATER QUALITY MEASUREMENTS

Sample Location	Sample Date	Sample Time	pH	ORP (mv)	Conductivity (uS/cm)	Temperature (C)	Ferrous Iron (mg/L)	Estimated Flow (gpm)
Pit Spring	9/23/2002	1046	7.06	159	417	7.54	0	4 to 5
Pit Creek at Falls through Waste Rock Pile No.2	9/23/2002	1100	8.05	156	408	16.8	0	4 to 5
Seep at base of Wast Rock Pile No.2 near Pit Creek	9/23/2002	1230	7.8	161	447	25.4	0	0
Pit Creek at Road (PC1)	9/22/2002	1745	8.21	168	418	12.15	0	8 to 10
Pit Creek above confluence with Red Rock Creek (PC2)	9/22/2002	1730	8.24	170	415	12.6	0	8 to 10
Red Rock Creek above confluence with Pit Creek (APC)	9/22/2002	1735	7.18	172	113	11.7	0	1 to 2
Red Rock Creek below confluence with Pit Creek (UC1)	9/22/2002	1720	8.15	170	384	12.8	0	5 to 10
Red Rock Creek near Canyon Outlet (UC2)	9/22/2002	1710	7.5	167	225	14.1	0	10 to 15
Red Rock Creek at head of meadow (MC1)	9/22/2002	1656	7.35	166	215	12.1	0	3 to 4
Red Rock Creek in upper meadow (MC2)	9/22/2002	1620	7.26	137	122	19.4	0	3 to 4
Red Rock Creek in middle meadow (MC3)	9/22/2002	1600	7.83	168	201	16.1	0	15 to 20
Red Rock Creek in lower meadow (LC1)	9/22/2002	1438	6.94	150	138	15.3	0	10 to 15
Red Rock creek at bottom of meadow (LC2)	9/22/2002	1525	7.12	162	143	13.7	0	30

JUNIPER URANIUM MINE
2004 WATER QUALITY MEASUREMENTS

Sample Location	Sample Date	Sample Time	pH	ORP (mv)	Conductivity (uS/cm)	Temperature (C)	Dissolved Oxygen (mg/L)	Ferrous Iron (mg/L)	Estimated Flow (gpm)
Pit Spring (PS)	7/7/2004	19:20	7.43	262.2	393	7.21	3.87	0	Too shallow to measure
Seep at base of Waste Rock Pile No.2 near Pit Creek (WR2)	7/7/2004	16:10	7.8	78.3	522	23.83	6.46	0	Standing Water
Pit Creek at Road Crossing (PC1)	7/7/2004	15:30	8.57	74.1	409	21.3	2.97	0	10.5
Upper Red Rock Creek Tributary (BUC)	7/7/2004	17:10	7.46	225.7	68	13.11	3.95	0	1.5
Red Rock Creek below confluence with Pit Creek (UC1)	7/7/2004	14:55	8.49	72.3	255	20.22	3.7	0	12.9
Red Rock Creek near Canyon Outlet (UC2)	7/7/2004	13:50	7.81	71.3	116	19.84	2.02	0	124.8
Red Rock Creek in middle meadow (M2)	7/7/2004	12:21	7.88	36.5	114	21.17	3.32	0	150.4
Red Rock Creek in lower meadow (LC2)	7/7/2004	10:50	7.12	84	113	11.26	10.7	0	156.1
Spring North of Waste Rock Pile No.1 (WR1)	7/7/2004	18:00	6.92	272.7	222	8.6	4.32	0	2
Background Spring at Head of Sardine Meadow (BG)	7/7/2004	18:45	7.44	212.6	232	11.46	4.71	0	0.1
Monitoring Well No.1 upgradient of the mine (MW-1)	10/1/2004	18:30	8.49	177	563	6.63	NM	0	Groundwater
Monitoring Well No.2 downgradient of the mine (MW-2)	10/1/2004	16:05	7.8	207	1207	9.75	NM	0	Groundwater

BOREHOLE LOG MW-1
FOCUSED SITE CHARACTERIZATION
JUNIPER MINE
U.S. FOREST SERVICE

Drilling Contractor: PC Exploration, Roseville, CA
Drill Rig Type/Method: Ingersoll Rand TH6O – Air Rotary
Borehole Diameter: 8 inches
Logged by: Brad Shelton

Time	Dates	Reading (µR/Hr	Depth	USCS Type/ Designation	Soil Description	% Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Silt/Clay
1455		15	5		Andesite – probably large boulder					
		15	10	SM	Silty sand, abundant Andesite chunks, reddish brown, Andesite is friable					
1520		15	15		Same as above, plus Rhyolite chunks. Andesite is less friable, more blocky					
		12	20		Change back to primarily friable Andesite.					
1620		15	25		Cuttings turn greenish grey. Still Andesite primarily, some silty matrix.					
1645		17	30	SP	Change to tuffaceous sandstone with Andesite. Very hard. Euhedral quartz grains (granular). Some Rhyolitic material. Mostly felsics – very fine. Pale grey.					
			35		Driller notes very hard, little to no recovery					
1830	9/9	15	~37							
				OL	1"x2"x3/8" piece of black siltstone in cuttings – friable. One side <1/10" black, rest is dark grey granular material (carbon?)	End of drilling 9/9/04				
0910	9/10									
0935	9/10	16	40	SP	Cuttings are same as 30'. Cuttings are mostly pulverized, some ¼" chunks.					
0950		14	45		Same as above.					
			~47		More carbonaceous OL in cuttings. Very thin. < ½".					
1020		16	49		Cuttings change to coarse grains, mostly Andesite, minor rhyolite, trace lithic fragments (feldspar, quartz). Driller going with lots of water. Seems to cut faster. Probable pebble conglomerate in SP=17@ 58'.					
			50	SP	Same as 40'.					
			52		Driller notes ~3' "void" at 52, no explanation					
1045		17	55	SW						
				SW	Sandstone – ctgs change to pale grey – almost blue mud. Fine sand with Andesite/Rhyolite grains.					
			58		Siltsone – hard, friable, dark bluish grey					
1105		14	60		Cuttings back to grey mud					
			65							
			70							
		14			~72 cuttings change to dark grey brown mud					
1120			75		Back to grey mud – no fragments big enough to tell lithology.					

BOREHOLE LOG MW-1
FOCUSED SITE CHARACTERIZATION
JUNIPER MINE
U.S. FOREST SERVICE

Time	Dates	Reading (μR/Hr	Depth	USCS Type/ Designation	Soil Description	% Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Silt/Clay
					Basically a fine grained mud.					
			78		Hand drilling, cuttings change back to coarse Andesite chips					
			80							
			85		Driller notes very hard – little recovery					
1150		15	90		Cuttings change to grey mud – fine grained sandstone.					
			95							
					Change to dark grey with Andesite chips.					
1200			100			End of drilling 9/10/04				
1055		12	105	CG	Conglomerate dark bluish grey – GLEY2 4/1 – hard, fine grained with Andesite chips. 15% clay (possibly conglomerate)					
		15	110	SP	Sandstone – bluish grey – GLGY24/1 – hard, fine to medium (no Andesite chunks). Angular medium grained quartz crystals, has sugary texture					
1115		15	115	CG	Change back Cg – Similar to 105, plus Rhyolite chunks to ½", minor clayey/sandy chunks					
1130		14	[118] 120		Color change to 10YR 5/3, brown, more Rhyolite, some iron oxide staining					
1140		14	125		Same as above.					
			[126]		Color change at 126 to 10YR 4/2, dark greyish brown					
			127		Abundant organic matter - ~30%					
1155		17	130	CG	Same as above, less Ryolite, no carbonaceous. Color is 10YR4/3, brown.					
1205		14	135		Same as above, color to 2.5Y 5/2, greyish brown.					
1220		15	140		Same as bove, color 10YR 4/3, brown, plus Ryolite, quartz, greyish brown chert (?)					
1335		14	145		Same as above, no chert					
1342		12	150	SW	Sandstone (? – could be tuff), very dark grey, 10YR 3/1, cuttings are brown, very hard, sugary texture, Andesite, quartz, subangular to angular [Cuttings water color change from brown to grey @ 152]					
1410		15	155		Same as above.					
		15	160		Same as above.					
1445		14	165		Same as above.					
1510		12	170 [172]		Same as above. Drilling fluid changes from mostly clear to grey mud.					
		12	175		Same as above, plus grey cherty pieces and black coal-like material, frequently joined to clear glassy quartz (obsidian?)					
			[178]		Cuttings less muddy.					
1530 [1645]		10	180 [180.5]		Andesite conglomerate (?), cuttings mostly ~1/2" Andesite with medium grained subangular quartz, matrix unknown.	End of drilling 9/14/04				
1005		12	185		Same as above, cuttings to 1", mostly Andesite, dark grey very hard sandstone chunks with angular, quartz and feldspar grains to 2mm, no fines.					
1011		10	190		Same as above, plus fines, less competent.					
					Grades into ↓					
1020		11	195	SP	Sandstone, mixed dark greenish grey (GLEY1 4/10) and grey	Tr		30	50	10

BOREHOLE LOG MW-1
FOCUSED SITE CHARACTERIZATION
JUNIPER MINE
U.S. FOREST SERVICE

Time	Dates	Reading (µR/Hr	Depth	USCS Type/ Designation	Soil Description	% Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Silt/Clay
					(GLEY1 S/N) chunks to 0.5", greenish chunks, hard, grey – soft, trace black Andesite, to 0.5" subrounded to subangular					
					Grades into ↓					
103 (break in drilling)		9	200	SC/SM	Clayey/silty sand, greenish grey GLEY 15/1, soft, plastic	Tr		20	50	30
105		11	[203] 205	SP	Sandstone, very dark grey GLEY 3/N,friable, soft, ~30% carbonaceous chunks, subrounded to angular, quartz, Andesite			30	30	10
1130		10	210		Same as above, grey GLEY1 5/N, trace carbon					
					Increasing fines.					
1140		12	215		Same as above, less fines.					
1155		13	220		Same as above, no carbon.					
1210		10	225		Same as above, plus 1/2" friable, very dark grey GLEY1 3/N chunks.					
1220		14	230	SW	Sandstone, very dark grey G1EY1 3/N, soft, slightly plastic. Subrounded Andesite/Rhyolite to ¾"	25	15	30	20	10
1230			235		Same as above.					
1235			240		Same as above, with abundant ~3/4" angular tuffaceous clasts. Clasts are greyish brown with ~2mm biotite inclusions					
1250 (9/15/04)			245	Tf	Ryodacite tuff, greenish grey, GLEY1 6/1, hard, smokey mins (quartz, etc.) to 2mm, biotite, conchoidal fracture					
END OF BORING TOTAL DEPTH = 245' bgs										

BOREHOLE LOG MW-2
FOCUSED SITE CHARACTERIZATION
JUNIPER MINE
U.S. FOREST SERVICE

Drilling Contractor: PC Exploration, Roseville, CA
Drill Rig Type/Method: Ingersoll Rand TH6O – Air Rotary
Borehole Diameter: 7.5 inches
Driller: Jared Kump
Logged by: Brad Shelton

Time	Dates	Reading (µR/Hr	Depth	USCS Type/ Designation	Soil Description	% Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Silt/Clay
1520	9/16/04	45	5	SM	Silty sand, greyish brown (10YR 5/2) hard subrounded to angular, andesite, quartz, tuffaceous clasts, andesite clasts	15	20	20	30	15
1540			10		Same as above, friable, andesite to 2"					
1555		55	15		Same as above, not friable, abundant iron staining, color change to 10YR 3/2, very dark grayish brown					
1610		45	20	SP	Sandstone, dark greenish grey (GLEY1 4/10GY) hard, has frosted appearance, bigger grains, angular, trace andesite to 1/4"	tr	15	20	60	5
		45	25		Same as above, change to very dark grayish brown (10YR 3/2), some lighter brown sandstone clasts					
1630		45	30		Same as above.					
1645		45	35	SP	Sandstone, dark greenish grey (GLEY1 4/10GY), hard, friable, some dark brown SS chunks, green elongate crystals to 2mm, dusky red (see below)	tr	35	45	20	Tr
1655		45	40		Same as above, change to very dark grey (5 YR 3/1)	End of drilling 9/16				
0830	9/17/04									
0845		52	45		Same as above, increasing dusky red (2.5 YR 3/2) chunks to 3/4"					
0900			50		Same as above, minor dusky red chunks					
0915		50	55		Same as above.					
0932		50	60		Same as above, trace dusky red chunks					
0955		50	65		Same as above.					
			[67]		Increasing dusky red chunks					
1015		50	70		Change to dark reddish grey (25 YR 3/1) hard, friable					
1035		50	75		Same as above, very hard, less friable, sugary texture, more tuffaceous, some weathered elongate grains (xtals)					
1055		50	80		Same as above, more friable, less tuffaceous texture					
1115		50	85		Same as above, more friable/almost fissile					
1135		45	90		Same as above, more fissile					
Total depth = 94 feet bgs										

FIELD INSTRUMENT CALIBRATION RECORD

Juniper Mine

Calibration Code: Juniper 6/30/04		Sheet of
Employee Performing Calibration:		Date: 6/30/04
Instruments:	**Standards:**	**Lot Number and Expiration Date:**
(1a) pH meter	pH = 7.00 Fisher SB107-500	3472 2/6/05
(1b) pH meter	pH = 4.00 Fisher SB98-500	4098 8/18/05
(1c) pH meter	pH = ~~5.00~~ 10 Fisher SB102-500	4074 2/5/05
(2) Specific conductance meter	Oakton 1,413 µS/cm	1404360 4/2005
(3) Specific conductance meter	Oakton 8,974 µS/cm	———
(4) Oxidation reduction potential meter	Hanna Instruments HI7020 Redox Solution (200 – 275 mV)	6167 7/2005
~~**(5)** DO meter~~	~~BP 693763~~ (corrected)	———
~~(6)~~ (5) DO meter	BP 693 mm Hg (corr)	
(7)		
(8)		
(9)		
(10)		

Instrument Calibration Data

Inst. No.	Time	Response As Found	Response As Left	Solution Temp (C)	Zero	Battery Check	Alarm Point	Notes
1a	0955	6.86	7.01	19.13	✓	✓		
1b	0958	3.91	4.00	18.41	✓	✓		
1c	1000	9.99	10.00	10.24	✓	✓		
2	1003	1371	1651	17.52	✓	✓		
3	1010	260.8	260.8	18.75	✓	✓		
4								
5								
6								
7								
8								
9								
10								

Review		*Action*
On-Site Health and Safety Officer	Date	
Site Manager/Project Manager	Date	
Health and Safety Review	Date	

FIELD INSTRUMENT CALIBRATION RECORD

Juniper Mine

Calibration Code: Juniper 07/07/04		Sheet 1 of 1
Employee Performing Calibration: mtw		Date: 7/7/04
Instruments:	**Standards:**	**Lot Number and Expiration Date:**
(1a) pH meter	pH = 7.00 Fisher SB107-500	3472 2/6/05
(1b) pH meter	pH = 4.00 Fisher SB98-500	4098 8/18/05
(1c) pH meter	pH = ~~5.00~~ 10.00 Fisher SB102-500	4074 2/5/05
(2) Specific conductance meter	Oakton 1,413 μS/cm	1404360 4/05
(3) Specific conductance meter	Oakton 8,974 μS/cm	NA
(4) Oxidation reduction potential meter	Hanna Instruments HI7020 Redox Solution (200 – 275 mV)	6167 7/05
(5) DO meter	BP@5600': 757mmHg 7360ft'	Stanislaus ranger Sta
(6)		
(7)		
(8)		
(9)		
(10)		

Instrument Calibration Data

Inst. No.	Time	Response As Found	Response As Left	Solution Temp (C)	Zero	Battery Check	Alarm Point	Notes
1a	0915	7.04	7.00	21.57	✓	✓		
1b	0918	4.03	4.00	21.17		✓		
1c	0920	10.03	10.00	19.63		✓		
2	0925	1548	1540	20.40		✓		
3	~~0930~~							
4	0930	156	243	20.12		✓		
5	0937	8.66	9.54	16.13				
6								
7								
8								
9								
10								

Review		*Action*
On-Site Health and Safety Officer	Date	
Site Manager/Project Manager	Date	
Health and Safety Review	Date	

FIELD INSTRUMENT CALIBRATION RECORD

Juniper Mine

Calibration Code:		Sheet 1 of 2
Employee Performing Calibration:		Date: 9/30/04
Instruments:	**Standards:**	**Lot Number and Expiration Date:**
(1a) pH meter	pH = 7.00 Fisher SB107-500	4000 6/10/2005
(1b) pH meter	pH = 4.00 Fisher SB98-500	4098 8/18/2005
(1c) pH meter	pH = ~~8~~ 10.00 Fisher SB102-500	6175 01/2005
(2) Specific conductance meter	Oakton 1,413 µS/cm	1406569 6/2005
(3) Specific conductance meter	Oakton 8,974 µS/cm	NA
(4) Oxidation reduction potential meter	Hanna Instruments HI7020 Redox Solution (200 – 275 mV)	~~691~~ ~~12/2006~~ 691 12/2006
(5) DO meter	BP @ 5600' = 756 mmHg; 736 @	8400' Stanislaus Ranger Stn
(6)		
(7)		
(8)		
(9)		
(10)		

Instrument Calibration Data

Inst. No.	Time	Response As Found	Response As Left	Solution Temp (C)	Zero	Battery Check	Alarm Point	Notes
1a	1040	7.06	7.00	22.8		✓		
1b	1045	3.62	4.00	20.5				
1c	1049	9.76	10.00	15.04				
2	1055	~~1.079~~ mS/cm	1413 @ 25°C	18.49				
3	—	—	—	—		—		
4	1108	180 mV	240	16.40				
5	1135	6.51	6.72	14.9		736mm		
6								
7								
8								
9								
10								

Review		*Action*
On-Site Health and Safety Officer	Date	
Site Manager/Project Manager	Date	
Health and Safety Review	Date	

FIELD INSTRUMENT CALIBRATION RECORD

Juniper Mine

Calibration Code:		Sheet 2 of 2
Employee Performing Calibration:		Date: 10/1/04
Instruments:	**Standards:**	**Lot Number and Expiration Date:**
(1a) pH meter	pH = 7.00 Fisher SB107-500	4000 6/10/05
(1b) pH meter	pH = 4.00 Fisher SB98-500	4098 8/18/05
(1c) pH meter	pH = ~~8~~ 10.00 Fisher SB102-500	6175 1/05
(2) Specific conductance meter	Oakton 1,413 µS/cm	1406569 6/05
(3) Specific conductance meter	Oakton 8,974 µS/cm	NA
(4) Oxidation reduction potential meter	Hanna Instruments HI7020 Redox Solution (200 – 275 mV)	691 12/06
(5) DO meter	BP @5600' = 756 mm Hg; 736 @ 8400'	SUMMIT STATION
(6)		
(7)		
(8)		
(9)		
(10)		

Instrument Calibration Data

Inst. No.	Time	Response As Found	Response As Left	Solution Temp (C)	Zero	Battery Check	Alarm Point	Notes
1a	1027	6.90	7.00	~~15.25~~ 15.92		✓ 4.2V		
1b	1031	3.87	4.00	14.79				
1c	1035	10.03	10.00	9.72				
2	1041	1.418 ms/cm	1.413 ms/cm @ 25°C	17.47				
3	—	—	—	—				
4	1046	281 mV	240 mV	~~11.82~~ 12.26				
5	1051	6.42	6.53	16.70				
6								
7								
8								
9								
10								

Review		*Action*
On-Site Health and Safety Officer	Date	
Site Manager/Project Manager	Date	
Health and Safety Review	Date	

TETRA TECH EM, INC.

Logbook No. #2

(For Single Project Use Only)

Project No.: G1Φ74.10.04

Project Location: TUOLUMNE COUNTY

Site ID/GPS: JUNIPER URANIUM MINE

Issuance No.	Date	Name	Last Page Used

Field Logbook No. Juniper Date 6/28/04

0745 - arrive @ office to pick up rental car + pack up supplies,

0800 - Spoke w/ Greg Meyer agree to meet @ ≈ 10:30 in Sonora. GR is traveling directly from Modesto

~~0845~~

0810 - Finish packing supplies. Need to find battery charger.

0830 - Depart office for Sonora

1050 - meet GM @ Alladin motor inn we will stay here for the week. leave GM's car here and depart for site.

1215 Heavy rain, hail + lightning make forest road travel slow.

1300 Arrive onsite rain is on/off now and fairly light. Overcast and ≈ 50-55 °F.

1320 Begin ~~map~~ surveying UC transects

Field Logbook No. Juniper Date 6/28/04

1730 complete UC transects 3-12. Put transects ≈ every 100' perpendicular to stream,

1745 Begin surface and 3' radiation surveys @ ~~UC 1-4~~ PC-3,4,5 & UC-3.

1930 Pack up supplys head off site.

2130 Arrive @ hotel after checking fed-ex location dropoff (Pack-go) opens @ 10:00 to late will call for fed-ex pickups instead.

12.5 hrs

Matt Witt

Field Logbook No. Juniper Date 6/29/04

0715 Depart hotel to pick up supplies @ albertsons and then to site.

0900 Arrive @ site attempt to locate springs in Sardine meadow.

0910 Unpack supplies. And continue radiation surveys. Weather Sunny +60°F.

1200 Complete radiation surveys for UC-4 through UC-12.

1210 Lunch

1225 Pack up for Low + Mid meadow transects.

1515 Complete Transects M-4 and LC 3, 4, 5.

1520 Pack up for remainder of Mid meadow transects.

1545 Wait out hail + lightning storm in truck. Get sample schedule organized during down time.

1655 Continue transect surveys.

2015 Complete transects M5 - M14

2020 pack up head back to hotel

2145 return to Hotel

14 hrs

Matt Witt

Field Logbook No. Juniper #2 Date 6/30/04

0730 Depart hotel to pick up supplies and to site. Stop @ ranger station for local weather data to calibrate YSI meter. (M. Walther, G. Meyer)

0930 Arrive onsite pack up for surface water sampling and calibrate YSI meter (see cal sheet)

1030 Complete calibration but we do not have Hach to measure Fe content. Instead we switch and decide to collect soil + sediment today.

1100 Depart for waste rock 3 to collect boring samples.

1150 @ WR3-1-S COLLECT 6"-12" COMPOSITE PORTION

1200-1330 REFUSAL ON ROCKS (5" max Φ) ATTEMPTED 4 AUGER HOLES W/ REFUSAL @ 12"-18" BGS. USED PICK-AXE & SHOVEL TO OVEREXCAVATE HOLES; ROCKS CONTINUOUS - REACHED EXCAVATION LIMIT W/ TOOLS (26") - MODIFIED SAMPLING DEPTHS (6-12", 13"-19" & 20-26")

1335 ~~06/30/04~~ -WR3-1-S-C COLLECTED!

Field Logbook No. Juniper Date 6/30/04

1350 Decon equipment for next sample @ TRUCK

1420 Similar conditions to 06/30/04-WR3-1-S-C sample. Used shovel + pick ax to collect sample. Composite of 6-12" 13-19", 28"-34". Took rad readings at each depth. ~~Each sample~~ 18, 17, 18 μR/hr respectively.

1455 06/30/04-WR3-2-S-C sample collected

1515 Collect background sample from Upper Red Rock creek, ~~Made composite from 4 locations~~ just upstream of confluence near waste rock 3. Made composite of 4 sub locations.

1555 Collect 6/30/04-BUC-SED-C.

1615 Decon equipment for final soil boring @ TRUCK TAPE & LABEL SAMPLES ABOVE & COMPLETE PAPERWORK.

1715 SIMILAR CONDITIONS TO 06/30/04-WR3-1-S-C SAMPLE. USED SHOVEL & PICK AX TO COLLECT SAMPLE. COMPOSITE OF 6-12", 19-25", & 28-34". TOOK RAD READINGS AT EACH DEPTH. 18, 16, & 16 RESP.

Field Logbook No. JUNIPER Date 6/30/04

1815 06/30/04-WR3-3-S-C
1820 RETURN TO TRUCK, DECON EQUIPMENT, RETURN TO STAGING AREA
1900 PACK & CHAIN (COC) SAMPLES (1 cooler) & COMPLETE PAPERWORK (COCs 6544 & 6530)
2000 DEPART SITE FOR HOTEL
2125 @ HOTEL

[illegible] 6/30/04

Field Logbook No. JUNIPER Date ~~6/30/04~~ 7/1/04

0710 DEPART MOTEL TO PICK-UP WINCH & SUPPLIES @ SITE STAGING AREA
0900 ARRIVE ONSITE, PREPARE OUTWASH AREA TRANSECT LAYOUT, UPPER BACKGROUND LAYOUT, & MISC GPS POINT COLLECTION.
1005 ① W-WR3 ~~-SE-SED~~
N699 ~~680.684~~ 877.939 E2062 ~~129.557~~ 374.767
② W-PC1
N699874.332 E2062358.251
③ BUC-SED-C
N699688.684 E2062129.557
④ WR3-3
N699775.093 E2062091.899
⑤ WR3-1
N699806.792 E2062166.213
⑥ WR3-2
N699819.333 E2062128.763
1020 START SL-UB-2 LAYOUT
1035 COMPLETE RAD SURVEY OF SL-UB-2
⑨ MW-1 LOCATION
N699969.837 E2062061.412
⑩ 2" Φ STAND PIPE w/ H_2O
N699911.288 E2062116.665

Field Logbook No. JUNIPER Date 7-1-04

1100 @ LOW WTR CROSSING/TRUCK - BEGIN ~~PLAN~~ OUTWASH AREA LAYOUT

1320 LUNCH

1340 Complete transects for outwash area (OA# 1, 2, 3, 6, 7, 8, 9, 10) Transects layed out by plotting known point and keeping parallel lines w/ compass.

Bearings

OA-1 start to bend ~~2°~~ ~~358°~~ 2°

OA-1 bend to end ~~358°~~ ~~2°~~ 358°

OA-7 end to start 260°

OA 1, 2, 3, 6 endpts along 92° bearing

1800 Complete transects ~~6A 4+5~~ OA4 + OA5 and

1815 Pack up truck. Unable to drive up access road to Staging area. Packed up truck from bottom instead. Did not get pit spring gps location because of extremely muddy conditions.

Pt. 37 W-WR1 - SPRING

N 700156.379 E 2062331.099

Field Logbook No. JUNIPER Date 7-1-04

PT. 38 W-UC-1 CONFLUENCE

N 699852.262 E 2062434.416

1920 Complete background survey SL-BM in Upper meadow ~~in upp~~ @ 10' spacing.

1945 gps W-BS on way off site.

PT. 41 N - 700588.608

E - 2062243.735

2345 return to office

[signature]

Field Logbook No. JUNIPER Date 7/6/04

0800 mtw arrive @ office to pack up gear and prep for Juniper sampling
0830 depart for Sonora
1030 meet gpm @ alladin motor inn, check in and depart for Juniper
1230 arrive @ Juniper eat lunch and prep for sediment sampling.
1415 collect sediment sample 07/06/04-LC-Sed-C @ LC4 transect
1500 collect sed sample 07/06/04-MM-sed-C @ M6 transect
1545 Collect sed sample 07/06/04-UM-Sed-C @ M14 transect
1645 collected sed sample 07/06/04-UC-sed-C @ UC 3 transect
1700 pack up samples beg rod survey of transect of OA-1 w/ 10' nodes,
1925 pack up truck head to hotel
2145 arrive @ hotel (stop 45 min dinner)

Field Logbook No. Juniper #2 Date 7/7/04

0715 depart for site. Stop to buy supplies on the way. (MTW + GPM)
0800 arrive @ ranger station to get BP data.
BP 29.8 in Hg
75.7 cm Hg
Temp 70.5 F
0930 arrive onsite calibrate YSI meter and pick up for H_2O sampling (See cal sheet)
1100 collect 07/07/04-LC2-W-G-F sample, field readings and flow profile.
Sample location 23' ds of LC-3 tran
flow measure " 103 " " " "
1221 Collect 07/07/04-M2-W-G-F sample field readings + flow profile
sample + flow location 16' US M6 tran.
1250 Lunch.
1300 Udell onsite to check fence maintenance
1350 Collect 07/07/04-UC2-W-G-F sample, field readings + flow profile
sample + flow location 62' US UC12 transect.

Field Logbook No. Juniper #2 Date 7/7/04

1455 - collect 07/07/04-UC1-W-G-F sample. field measurements + flow profile 28' OS of UC-3 transect.

1530 collect 07/07/04-PC1-W-G-F (+unfiltered to MA) sample and field measurements. Used bucket + timer to estimate flow @ 10.5 gpm.

1600 Collect 07/07/04-WR2-W-G-F ~~(+unfiltered for MA)~~ sample, field measurements. ~~Used~~ Spring sample no flow measurement

1710 Collect 07/07/04 BUC-W-G-F (+unfiltered for MA) sample, field measurements. Low flow, estimated at 1.5 gpm, no flow profile possible.

1800 collect 07/07/04-WR1-W-G-F sample and field measurements. Flow estimated at 2.0 gpm.

1845 collect 07/07/04-BS-W-G-F sample and field measurement. < 0.5 l/min flow.

Field Logbook No. Juniper #2 Date 7/7/04

1920 GPM samples Pit spring 07/07/04-PS-W-G-F (and unfiltered). Collect sample and field parameters

1940 Clean up and pack up samples

2015 Head off site

2150 arrive @ hotel

Field Logbook No. Juniper #2 Date 7/8/04

0715 Pack up samples to go out via fed-ex this morning.
0830 depart for site + supplies.
1020 Arrive onsite meet up w/ Matt Udell, Tamara Zidlinski, Brad Shipley also onsite for inspection.
1040 Pack up truck to complete rad survey of Transects.
1045 Begin OA2 Transect.
1230 Lunch
1250 Begin OA3 Transect.
1400 Survey transects OA-6, OA-7, OA-8 OA-9, OA-10, OA-4, OA-5
1750 Return to OA2 and resurvey portion because got off line at some point.
1900 Pack up supplies leave only decon drum onsite w/ radioactive label on it w/ Udell as contact.
1945 off site to hotel.
0030 (7/9/04) return to office + unload truck + equipment.

Field Logbook No. Jun ~ #2 Date 9/9/04

Juniper Mine Well Install
Brad Shelton - TTEMI
0630 Leave Sonora
0800 Arrive in Mine Area
0815 Locate Drillers at Camp near granite outcrop
PC Exploration
Jarod Kump - Driller
Sonny Sobolak - helper
Set up camp, talk about previous day. Drill rig blew tires on highway 99. Crew arrived onsite ~ 6pm 9/8. Support truck delivered previous day.
0915 Leave camp: Crew searches for water source. Support truck was unable to climb a hill to Mine site with water on previous day (over heated). Will get water from Stock pond on SN01 ~ .5 miles back down road. Creek at Red Rock meadow is dry.
0930 Back at Juniper mine pad area. Off load equipment.
0945 Tailgate H+S meeting.

Field Logbook No. Juniper #2 Date 9/9/04 cond

0945 (contd) Topics include Heat, Cold, rig safety, bears, STEs
Decide in case of emergency, mainly forest fire, to meet at decon pad and decide what to do from there
1000 Continue off loading/setup
1010 Conduct Rad screen of support vehicle
1200 Continue setup. Moving materials to both locations.
1350 Rig setup on MW-1
1355 Begin drilling
1830 Stop for the day. Total depth drilled today is approximately 37' bgs.
Driller notes very hard conditions.

Brad Sla
9/9/04

Field Logbook No. Juniper #2 Date 9/10/04

0700 Break camp for the weekend
0800 Arrive at drill rig already setup on MW-1 from previous day.
0815 Fitting on aux diesel tank broken. Have to repair to fill drill rig
0845 Fitting fixed. Fuel up rig
0900 All vehicle in place
Driller discusses poor condition of roads. Work by WA Craig not to marked design. Will discuss with Matt Udell on return to SAC this afternoon
0910 Commence drilling
1200 Stop drilling for the day. Total depth so far is 100' bgs.
Go to dump cuttings at WR-1.
Fill out paperwork at decon area
1300 Leave site for Sacramento

Brad Slater
9/10/04

Field Logbook No. Jumper #2 Date 9/13/04

0630 Leave Sonora for mine site.
0800 Stop at Summit Ranger District to notify them of workers at Jumper in case of emergency.
0900 Arrive at mine site. Jarod (PCK) onsite. Helper will be here tomorrow. Also - Motor mounts on rig are in disrepair, might be from accident on 9/8. Jarod does not want to run rig until Ok'd with office. Will travel to windy ridge to try and get cell service. He ~~is~~ 's using a tree trunk to grade/drag road to upper pad to remove excess rock/debris.
0950 Travel to camp site. Will wait on word from Jarod how to proceed.
1130 Jarod arrives back at camp. Will have to replace motor mounts before drilling. Mob to rig to remove broken mounts.
1430 Mob to Sonora
1645 leave Sonora. Will repair with ~~plas~~ rubber shims.
1840 Arrive back onsite. Start repairing rig.
2020 Finish repairing rig. Mob to camp

Brad [signature] 9/13/04

Field Logbook No. Jumper #2 Date 9/14/04

0830 Mob to drill pad MW-1
0955 Driller takes support truck to get water. Unloaded supplies on drill pad to make truck lighter.
1030 Driller back on site.
1040 Begin drilling (at 100' bgs)
1230 Drill rig running hot. Will stop for a bit and let cool off, eat lunch
1315 Resume drilling. Approximately 15-20 gallons water in hole. Was a fair amount this am also.
1645 Finish for the day. ~~Drilled to~~ Drilled from 180 to 180.5 for last hour.
1700 Return to camp

Brad [signature] 9/14/04

Field Logbook No. Juniper #2 Date 9/15/04

0800 Mob to drill pad MW-1.
Fuel up rig, get water, etc.
0935 Begin drilling at ~190.5' bgs
1030 Drilled to 200'. Pause in drilling for driller to climb hill to send text message about lack of helper. (Was supposed to arrive 9/14)
1100 Driller returns. Was not able to get out. Drilling Resumes
1250 Reach td in a welded tuff. Blow hole for about ten minutes to clean out.
1315 Hike up hill to call PCK office about status of helper.
1415 Return to well pad.
1420 15-20 gallons in hole. will set well. ~~trip out.~~
1500 Finish trip out. Build well td = 245' 40' screen (010)
1640 Well taking more sand than anticipated - probably blown out a little
1720 Placed 9 bags 8/12 sand to 201' bgs
Screen is 204.5 to 244.5 (0.5" endcap to 245)
Placed 2 bags 3/8 baroid to 194' bgs
1745 Depart drill pad.
1800 Return to Camp

Brad Shelton

Field Logbook No. Juniper #2 Date 9/16/04

0745 Leave Camp
0800 Arrive at MW-1
0815 Tailgate H&S meeting conducted by Brad Shelton
J. Kump, D. Alberts (PCK) in attendance.
0825 Set up rig for grouting
Refuel, get water etc.
0920 Tag water in well at ~145' bgs
Water from upper zones in well, will ~~to~~ get accurate level after ~~development~~
1010 Tremie pipe installed.
1215 Finish grouting MW-1
Used ~~22~~ 23 bags portland, 2 bags powdered bentonite (Aquagel Gold seal)
1345 Mob off MW-1 to decon pad.
Decon rig + ~~rods~~.
1500 Mob to MW-2.
Rad levels at pad range from 20 to 60 µR/hr at pad, peaking near 170 at road.
1520 Begin drilling MW-2
1700 End of drilling for the day. Depth is 40' bgs
1715 Return to camp.

Brad Shelton 9/16/04

Field Logbook No. Juniper #2 Date 9/17/04

0745 Depart camp.
0800 Arrive at drill pad (MW-2)
Fuel up rig, get water etc.
0820 Tailgate H+S meeting Kump Alberts
0830 Blow hole. Approximately 10-15 gallons
water in hole. Resume drilling
1200 End of drilling for the day. ~94' bgs.
1215 Left site for Sacramento.

Brad Shipley 9/17/04

Field Logbook No. Juniper #2 Date 9/20/04

0830 Leave Sacramento
1200 Arrive at Mine. Storm has
left patchy snow around site.
T. Zielinski (TTEMI) and Peter
from WA Craig onsite
1210 Brad Shipley (USFS) arrives
1212 Leave mine to check on camp
1215 Starts snowing. Temp about 35°
~1 inch snow at camp
1230 Return to mine.
1300 T. Zielinski, B. Shipley depart site.
WA Craig crew arrives.
1315 Snow showers cease.
1345 WA Craig (Peter) conduct
H+S meeting.
1405 WAC crew starts work
1425 PL Ex arrives.
1435 Support truck will not start.
1445 Fixed truck, mob to well.
1505 Rig warmedup.
1530 Measure water in hole at
~26' bgs. Will build well with
td=90, 40' 020 (thats all we have) and
extend sand pack ~20 up (to around 27)
1620 Start placing Filter pack 2/12

Field Logbook No. Juniper #2 Date 9/20/04

1700 Leave site for camp

9/20/04

Field Logbook No. Juniper #2 Date 9/21/04

0800 Leave camp for Mine
0810 Arrive at MW-2 well pad
0815 Tailgate H+S
0830 Discuss plan for completion
0935 Start mixing grout. Will mix one batch, grout MW-2, and then ~~take~~ the rest up to MW-1 to ~~top~~ it off.
1015 Finish placing grout. Install Lock box.
1035 Jarod leaves to take extra grout to MW-1
1105 Jarod returns. Start surface completion of MW-2.
1300 Finish surface completion on MW-2. Peter (WAC) arrives. Wants to know gamma levels in Stream area where crew is working
1310 Gamma levels at road construction area range from 40-70 μR/hr. Levels up to 100 are found higher up stream, where ~~the~~ waste rock occurs. (NOT IN CONSTRUCTION AREA) Will notify Peter that workers are ok if they stay out of wasterock area.
1435 Finish completion of MW-1,

Field Logbook No. Juniper #2 Date 9/21/09

1525 Mob to decon pad,
Decon Rig, pack up equipment.
1630 Return to camp. Pack up.
Drillers will leave tomorrow am.
1700 Depart Camp

Field Logbook No. Juniper #2 Date 9/23/09

Lower Well (MW-2) 1150
TOC 92.84 ft
DTW 11.61 ft

Upper Well (MW-1) 1330
TOC 247.0 ft
DTW 69.75 (questionable)
problems w/
meter

Field Logbook No. JUNIPER #2 Date 9/30/04

MDU & GPM

0700 MEET @ ALADDIN MOTOR INN, TO ALBERTSONS FOR SUPPLIES & LUNCH MAT'LS.

0730 CONTACTED PC EXPLORATION, ALEX MET UP ON HWY 108 @ STANDARD

0800 @ SUMMIT RANGER STATION GATHERED BP/TEMP FROM GAUGES INSIDE

BP = 29.77 in Hg / 75.6 cm Hg

@ 5600' 80°F / 65°C

0930 @ MINE GATE, TRAVELED TO UPPER WELL MW-1; SET-UP / CALIBRATE INSTRUMENTS / HELD HEALTH & SAFETY MTG -- ALL PARTIES SIGN OFF

1030 DECON DEVELOPMENT SURGE BAILER/BLOCK W/ RADIAC/LIQUINOX/DI WATER SOL'N. ; RINSE W/ DI. DECON WIRE REAL AS WELL

1045 SOUNDED TD = 247

INT. DTW = 191.81

BEGIN DEVELOPMENT

Field Logbook No. JUNIPER #2 Date 9/30/04

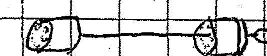
MARK REAL WIRE @ 247' & 207'

PULLED OUT SURGE BLOCK/BAILER - NOTED PVC SHAVINGS IN BAILER TIP. BAILED @ DEPTH TO REMOVE PVC. CONTINUED SURGING W/ BAILER - BAILED SEDIMENTS/ SANDS

1200 SWITCH CHECK VALVE - NOT SEALING

1225 ~~NEW~~ NEW CHECK VALVE BROKEN - POLISHED SEAT ON ORIGINAL CHECK VALVE -- CONT. BAILING

1245 SWITCHED TO SURGE BLOCK



1300 HAILING 1/4" - 3/8" ø HAIL & LIGHTING

SWITCHING BACK TO BAILER

15 MINUTE BREAK DURING LIGHTNING

1330 END BAILING ~30 GALS PURGED - PREPARE TO SEND PUMP/TUBING/POWER CABEL/SAND LINE DOWN WELL

1400 PUMP @ DEPTH; ISSUES W/ GFI PLUG & PUMP CONTROLLER; GFI POPING. ISSUES W/ GENERATOR RESTART

Field Logbook No. JUNIPER #2 Date 9/30/04

SWITCHED NEUTRAL / HOT LINES
ON PUMP ; DISCONNECTED
GROUND ON GFI - PUMP
FUNCTIONS

DOWN HOLE - NO DRAW

REMOVED PUMP LEAD
TO CHECK FUNCTION IN
DRUM OF H_2O. NOTED
BALL OF SAND LINE
UPON REMOVAL.

RE-PLACED PUMPED @
DEPTH - NO DRAW - TRIED
TO PRE-FILL LINE -- DRAINED
OUT.

1704 ASSUMED PUMP NOT BELOW
WATER, -- CONFIRMED UPON RATS
NEST REMOVAL. ADDED CHAIN
& BAILOR FOR WEIGHT.
LOWERED ASSY & BANDED
LINES DURING ASCENT.

Field Logbook No. JUNIPER #2 Date 9/30/04

1730 PUMPING UNABLE TO OVERCOME
HEAD - BY PASSED GFI -- STILL
UNABLE TO DRAW PRIOR TO
HEAT RELATED SHUT-OFF. SECURE
WELL SITE / SUPPLIES

1900 DEPART SITE

2030 @ MOTEL

9/30/04

Field Logbook No. JUNIPER #2 Date 10/1/04

0700 GPM/MDU DEPART ALADDIN MOTOR INN -- TO ALBERTSON'S & NAPA AUTO PARTS FOR SUPPLIES.

0735 DEPART NAPA FOR SITE

0900 ON-SITE. MOB EQUIPMENT FROM MW-1 TO MW-2.

1000 - DECON BAILER & SURGE BLOCK @ MW-2

1030 BEGIN EQUIPMENT CALIBRATION ~~RC~~ EXPLORATION ON SITE - SET-UP ON MW-2.

1045 BEGIN BAILING @ TD. SOME PVC SHAVINGS & SAND REMOVED, WATER MUCH CLEANER THAN MW 1; DECONING PUMP WIRE LEAD

1130 END BAILING, ~40 GALS REMOVED.

1135 CONNECT SURGE BLOCK / BEGIN SURGING DECON BAILER FOR USE @ MW-1

1205 END SURGING; DECON SURGE BLOCK FOR END OF USE. SET-UP PUMP/TUBING/WIRE HARNESS, LOWER INTO MW-2 (2-FT FROM BOTTOM).

Field Logbook No. JUNIPER #2 Date 10/1/04

1252 BEGIN PUMPING MW-2 @ 2gal/min

1255 INITIAL PARAMETER TAKEN

1313 MW-2 PARAMETER

1329 MW-2 @ 55gal PURGED

1340 MW-2 WATERLEVEL BELOW PUMP INLET

(BEGAN BAILING @ 1220 IN MW-1; MW-1 INITIAL/FIRST PARAMETER @ 1328 NOTE: STAINLESS BAILER INITIALLY LEAKING - UNABLE TO SERVICE/REPAIR -- SWITCHED TO PVC BAILER; ~~(APPROX. 60 gals PURGED; OPAQUE)~~ APPROX 60 gals purged [INCLUDES 30 gals from 9/30 BAIL/SURGE/CLEAN-OUT])

1400 MW-2 RECHARGE RATE ~ 0.088 gal/min

UPON RESTART @ 1400 ~1.75 gals removed

1420 MW-2 PUMP RESTART - 1.5 gals REMOVED; ~~DRY~~ WATER BELOW PUMP INLET -- WILL ALLOW RECOVERY FOR SAMPLING (~1 HR);

TOTAL 116 GALS REMOVED (~40 BAILED DURING CLEAN-OUT/SURGE & 76 PUMPED)

1455 @ MW-1 - WELL PURGED DRY @ ~75 gals

1523 MW-1 PARAMETER ~1' H_2O IN WELL.

Field Logbook No. JUNIPER #2 Date 10/1/04

MOVE TO MW-2; PREPARE TO SAMPLE

1605 COLLECT SAMPLE FROM MW-2
FILTER SELLECTED VOLUMES
REQUIRED 6 - LOW CAPACITY
FILTERS TO FILTER 6 L.
PULL UP PUMP - DECON
WIRE LEAD & PUMP - PACK
UP SOME SUPPLES

1750 MOVE TO MW-1 TO CHECK
RECOVERY. DTW = 240.43'.

1800
PREPARE TO SAMPLE.

1830 COLLECT MW-1 SAMPLE;
WILL FILTER @ OFFICE
W/ HIGH FLOW FILTER

DECONED BAILERS USED @ MW-1

1900 PC EXPLORATON OFF SITE

2000 PACKED UP - SECURED ALL
GATES INCLUDING A CATTLE
GATE TO MW-1 - OFF SITE

[signature] 10/1/04

Field Logbook No. Date

Closest to WR-2 face

Parallel to face of WR-2 WR-1

100 ft Spacing reading every 10 ft

Outwash Area Survey Line No. OA-1

Start GPS N699866.254 E2062390.524 meters

23 End GPS N700228.383 E2062504.738 ← COINCIDENT w/ OA-10 END; STORED AS OA-10 END

13 Bend GPS N700096.609 E2062494.265

hit obvious gullies on each transect

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0 NEAR AT CAK			33	33
	10			30	29
	20			39	35
	35			38	36
	40			28	30
	50			30	31
	60			33	33
	70			37	35
	80			37	35
	85			29	32
	100			29	29
	110			30	29
	118			30	28
	130			30	30
	140			30	28
	150			27	30
	160			26	27
	170			29	32
	180			26	29
	190			28	28
	200			27	27
	210			28	28
	220			34	34
	230			37	33

Survey Date 07/06/04 Personnel MTW / GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/6

Outwash Area Survey Line No. OA-1
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			27	31
	247			24	31
	260			30	30
	270			30	30
	280			28	32
	290			35	37
	301			37	38
	310			30	29
	326			28	30
	330			28	28
	340			29	28
	350			30	29
	360			30	21
	370			48	43
	375			50	44
	385			32	35
	400			28	31
	410			30	31
	420			30	34
	430			33	29
	440			33	31
	450			35	35
	460			32	35
	470			38	43

Survey Date 7/6/04 Personnel MTW/GPM
GPS Datum NAD 83 CSP ZON 3 Equipment LUDLUM SURVEY MTR, MODEL 3

2/6

Outwash Area Survey Line No. OA-1
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	477			55	55
	490			37	40
	500			36	38
	510			38	38
	520			34	34
	530			36	38
	PM ~~3~~ 540			35	40
	550			33	33
	560			35	36
	570			31	35
	580			33	36
	590			40	40
	600			65	50
	610			34	36
	620			33	33
	630			35	30
	640			28	31
	650			28	27
	660			32	32
	670			32	32
	680			32	34
	690			30	30
	700			29	32
	710			36	42

Survey Date 7/6/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

3/6

Outwash Area Survey Line No. OA-1
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	720			37	35
	730			40	40
	740			35	35
	750			90	70
	760			40	40
	770			38	42
	780			39	50
	790			48	43
	800			30	33
	810			30	31
	820			31	27
	830			27	28
	835 (OA-1 BEND)			29	27
	840			30	30
	850			49	42
	860			60	50
	870			55	45
	880			47	40
	890			30	30
	900			29	29
	910			28	25
	920			25	24
	930			28	27
	940			34	35

SETTLING POND OUT FROM SIGNIFICANT RUT @ N END OF WR2

Survey Date 7/6/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

4/6

Outwash Area Survey Line No. OA-1
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	950			48	44
	960			65	50
	970			80	60
	980 (983 @ OA-7 END)			70	60
	990			60	60
	1000			60	60
	1010			37	41
	1020			31	35
	1030			65	50
	1040			60	50
	1050			40	37
	1060			33	35
	1070			33	33
	1080 (1084 @ OA-8 END)			26	26
	1090			23	23
	1100			20	22
	1110			20	20
	1120			20	20
	1130			20	21
	1140			19	20
	1150			17	21
	1160			18	18
	1170			18	18
	1180			18	16

Survey Date 7/6/04 Personnel MTW/GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

5/6

OUTWASH AREA
~~Waste Rock Pile No.2~~ Survey Line No. OA-1
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	1190 (OA-9 END)			17	17
	1200			15	17
	1210			18	18
	1220			16	17
	1230 (@FENCE)			17	18
	1240			17	17
	1250			18	16
	1260			18	17
	1270			18	16
	1280			18	18
	1290 (OA-1 END/ OA-10 END)			17	17

Survey Date 7/6/04 Personnel MTW /GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR.

6/6

Outwash Area Survey Line No. OA-2

Start GPS N699855.000 E2062415.326 METERS

28 End GPS N 700224.176 E 2062534.339

19 Bend GPS N700094.834 ~~E2062529.808~~ E2062521.046

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			38	38
	16			36	36
	20			35	35
	30			35	36
	40			35	34
	50			34	34
	60			33	33
	70			34	34
	80	REVISED DOWNHILL TRANSECT		33	32
	90	SURFACE ~~REVISED~~	3 FOOT	34	33
	100	~~NR~~	~~NR~~	33	32
	110	28	28	28	27
	120	29	28	28	28
	130	25	24	25	25
	140	25	23	26	24
	150	24	24	23	24
	160	24	25	25	25
	170	26	25	24	25
	180	25	25	24	25
	190	23	21	25	26
	~~200~~ 191	~~23~~ NR	~~22~~ NR	25	25
	200	23	22	25	25
	210	23	22	24	26
	220	24	24	25	26

Survey Date 7/8/04 Personnel MTW / GPM

GPS Datum NAD83 CSP ZONE3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/6

Outwash Area Survey Line No. OA-2
Start GPS
End GPS

REVISED DOWNHILL TRANSECT

Point Number	Distance from End	~~Northing~~ SURF.	~~Easting~~ 3 FT.	Surface (uR/hr)	3 foot (uR/hr)
	230	26	25 –	28	28
	240	25	27	28	28
	246	38	32 –	30	31 –
	260	25	27	28	29
	270	24	26	28	28
	280	25	24	36	34
	290	21	23	41	35
	300	20	23	25	30
	310	26	24	28	28
	320	28	24	28	28
	330	24	24	28	29
	340	23	23	27	27
	350	25	26	25	29
	360	358 28	38 –	28	30
	370	25	24	60	40
	380	25	25	38	34 –
	389	390 27	25	27	25
	400	24	24	27	27
	410	25	26	29	31
	420	23	24	28	27
	430	25	24	26	27
	440	437 36	31 –	28	30
	450	25	25	24	29
	460	23	27	30	30

Survey Date 7/8/04 Personnel MTW / GRM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

2/6

Outwash Area Survey Line No. OA-2
Start GPS ______ ______
End GPS ______ ______

REVISED DOWNHILL TRANSECT

Point Number	Distance from End	~~Northing~~ SURF.	~~Easting~~ 3 FT.	Surface (uR/hr)	3 foot (uR/hr)
	470	25	25	30	33
	476	25	23	37	32
	490	25	25	31	30
	506	25	25	27	28
	510	25	25	29	29
	520	22	21	37	27
	530	25	23	28	28
	540	21	26	29	29
	550	27	25	31	32
	560	25	27	28	29
	570	24	26	27	28
	580	25	27	28	28
	590	26	30	27	31
	~~599~~ 600	60	50	35	36
	610	25	28	25	25
	620	26	25	25	27
	630	25	27	25	29
	640	24	25	23	24
	650	29	29	25	23
	660	29	29	26	27
	666	25	25	27	26
	680	27	26	28	28
	690	28	30	28	28
	700	36	35	25	26

Survey Date 7/8/04 Personnel MTW / GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

3/6

Outwash Area Survey Line No. OA-2
Start GPS ______ ______
End GPS ______ ______

REVISED DOWNHILL TRANSECT

Point Number	Distance from End	~~Northing~~ SURF.	~~Easting~~ 3 FT.	Surface (uR/hr)	3 foot (uR/hr)
	710	25	26	29	28
	720	25	26	27	27
	730	27	27	23	25
	740	25	25	25	25
	750			25	25
	760		BACK ON ORIGINAL	24	24
	770		OA-2 TRANSECT	23	21
	780			21	21
	790			25	23
	797			20	25
	810			24	27
	820			21	22
	830			22	21
	840			20	21
	850 (OA-2 BENT 857)			20	22
	860			24	22
	870			20	20
	880			20	22
	890			21	23
	900			24	22
	910			19	19
	920			20	19
	930			18	19
	940			19	19

Survey Date 7/8/04 Personnel MTW /GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

4/6

Outwash Area Survey Line No. OA-2
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	950			20	19
	960			20	20
	970			18	18
	980			18	18
	990			20	19
	1000			20	19
	1010			20	19
	1020			23	23
	1030			21	23
	1040			25	28
	1050			27	29
	1060			49	45
	1070			65	50
	1080			55	45
	1090			50	45
	1100			60	40
	1110			37	34
	1120			32	28
	1130			27	26
	1140			24	24
	1150			22	22
	1160			22	21
	1170			20	20
	1180			20	18

Survey Date
GPS Datum
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

5/6

Outwash Area Survey Line No. ØA-2
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	1190			18	19
	1200			18	22
	1210			20	22
	1220			18	20
	1230			24	20
	1240			24	23
	1250			27	28
	1260 (FENCE)			60	40
	1270			40	30
	1280			28	24
	1290			18	18
	1300			15	16
	1307 (OA-2 END)			18	18

Survey Date 7/8/04 Personnel MTW/GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEYMTR

6/6

Outwash Area Survey Line No. OA-3

Start GPS N 699862.653 E 2062451.277 METERS

28 End GPS N 700214.775 E 2062562.319

18 Bend GPS N 700085.481 E 2062549.620

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			35	31
	10			35	34
	20			29	30
	30			33	33
	40			35	30
	50			31	31
	60			29	28
	70			28	21
	80			31	27
	90			28	26
	100			~~10~~ 24	23
	110			20	24
	120			21	22
	130			23	23
	~~137~~ 137			25	25
	150			26	27
	160			27	27
	170			37	32
	180			32	31
	190			26	25
	200			24	24
	210			21	21
	220			21	25
	230			23	23

Survey Date 7/8/04 Personnel MTW/ GPM

GPS Datum NAD83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/6

Outwash Area Survey Line No. OA-3
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			21	23
	250			22	23
	260			21	21
	270			27	25
	280			20	21
	290			20	20
	300			21	21
	310			21	21
	320			22	22
	330			20	21
	340			20	20
	350			20	20
	360			24	21
	370			20	22
	380			22	23
	390			20	24
	400			21	23
	410			20	18
	420			19	17
	430			21	18
	440			17	20
	450			19	19
	460			18	17
	470			18	18

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW GPB
Equipment LUDLUM MODEL 3 SURVEY MTR

2/6

Outwash Area Survey Line No. OA-3
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	480			17	18
	490			19	19
	500			19	18
	510			19	17
	520			17	19
	533			30	25
	540			24	24
	550			22	19
	558			20	20
	570			20	20
	580			20	20
	590			20	20
	600			21	22
	610			21	26
	620			19	19
	630			19	19
	640			20	20
	650			19	20
	660			20	19
	670			21	19
	680			19	18
	690			23	20
	700			21	21
	710			21	19

Survey Date 7/8/04 Personnel GPM / MTW
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY METER

3/6

Outwash Area Survey Line No. OA-3
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	720			19	21
	730			17	20
	740			18	19
	750			19	20
	760			16	20
	770			17	17
	780			19	20
	790			17	17
	800 (OU-3 BEND @797)			23	20
	810			22	25
	820			24	22
	830			22	20
	840			21	20
	850			19	19
	860			22	20
	870			20	20
	880			19	19
	890			20	20
	900			19	19
	910			22	21
	920			20	19
	930			20	20
	940			21	21
	950			20	19

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW -GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

4/6

Outwash Area Survey Line No. OA-3
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	960			20	20
	970			20	20
	980			20	18
	990			19	19
	1000			23	25
	1010			24	25
	1020			27	27
	1030			27	25
	1040			24	24
	1050			20	21
	1060			32	26
	1070			23	25
	1080			30	28
	1090			29	27
	1100			30	26
	1110			27	27
	1120			30	29
	1130			40	33
	1140			27	27
	1150			20	21
	1160			19	21
	1170			19	19
	1180			24	20
	1190 (FENCE @ 1198)			20	19

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW/ GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

5/6

Outwash Area Survey Line No. OA-3
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	1200			18	20
	1210			19	17
	1220			18	18
	1230			17	15
	1240			17	17
	1250 (OA-3 END 1251)			19	19

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW/ GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

6/6

Outwash Area Survey Line No. OA-4

34 Start GPS N 699941.445 E 2062550.498 METERS

32 End GPS N700048.168 E 2062570.860

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			40	40
	10			42	38
	20			30	31
	30			28	30
	40			32	30
	50			26	28
	60			21	21
	70			20	20
	80			19	20
	90			21	21
	100			20	20
	110			20	20
	120			20	20
	130			21	21
	140			24	27
	150			32	32
	160			21	22
	170			21	20
	180			22	20
	190			20	20
	200			19	22
	210			~~20~~	18
	220			20	20
	230			21	20

Survey Date 7/8/04 Personnel MTW / GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM SURVEYMTR (MODEL 3)

1/2

Outwash Area Survey Line No. ~~OA-5~~ OA-4

~~35 Start GPS N649967.623 E 2062585.401~~ METERS

~~33 End GPS N700036.751 E 2062600.842~~

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			18	18
	250			18	17
	260			21	20
	270			23	23
	280			22	23
	290			23	21
	300			20	21
	310			20	20
	320			20	19
	330			19	19
	340			22	18
	350			19	20
	360 (OA-4 END)			23	23

Survey Date 7/8/04 Personnel MTW / GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

2/2

Outwash Area ~~Waste Rock Pile No.2~~ Survey Line No. OA-5

35 Start GPS N699967.623 E 2062585.401 meters

33 End GPS N700036.751 E 2062600.842

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			38	38
	~~20~~ 10			40	44
	20			70	60 RRC
	30			70	60 FLOOD PLAIN
	40			60	50
	50			33	33
	60			25	24
	70			24	24
	80			23	23
	90			23	21
	100			23	22
	110			19	21
	120			25	25
	130			27	26
	140			26	24
	150			26	26
	160			25	27
	170			25	25
	180			25	25
	190			27	27
	200			29	26
	210			28	28
	220			30	30
	230			29	30
	238 (OA-5 END)			27	27

Survey Date 7/8/04 Personnel GPM /MTW

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

X

Outwash Area Survey Line No. OA-6

31 Start GPS N 700 129.382 E 2062572.054 METERS

30 End GPS N 700 208.366 E 2062592.164

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			19	20
	10			17	21
	20			21	19
	30			19	20
	40			19	19
	50			19	19
	60			~~18~~ 20	~~20~~ 18
	70			20	20
	80			14	14
	90			16	18
	100			20	20
	110			20	19
	120			20	19
	130			20	19
	140			22	20
	150			20	16
	160			15	17
	170			16	16
	180			14	14
	190			15	14
	200			14	14
	210			13	13
	220			14	13
	230			14	14
	240			16	17
	250			13	15
	260			17	18
	270			15	17

Survey Date 7/8/04

Personnel MTW / GPM

GPS Datum NAD 83 CSP ZONE 3

Equipment LUDLUM MODEL 3 SURVEY MTR

1/1

Outwash Area Survey Line No. OA-7

36 Start GPS N 700153.872 E 2062326.973 meters

20 End GPS N700147.065 E2062494.808

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			34	32
	10			37	39
	20			36	28
	30			25	25
	40			29	29
	50			32	30
	60			34	32
	70			30	28
	80			28	28
	90			30	32
	100			32	30
	110			32	30
	120			28	28
	130			28	28
	140			24	28
	150			28	28
	160			27	28
	170			27	28
	180			26	25
	190			28	27
	200			26	26
	210			27	30
	220			28	30
	230			28	28

Survey Date 7/8/04 Personnel MTW/GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/3

Outwash Area ~~Waste Rock Pile No.2~~ Survey Line No. OA-7
Start GPS
End GPS

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			43	35
	250			34	35
	260			28	34
	270			65	50
	280			28	34
	290			23	27
	300			25	27
	310			28	28
	320			25	26
	330			24	25
	340			24	24
	350			24	24
	360			25	26
	370			24	26
	380			25	25
	390			21	24
	400			23	23
	410			20	~~50~~ 23
	420			60	50
	430			60	50
	440			31	29
	450 (458 = ℄ SN33			25	26
	460			25	23
	470			24	28

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

2/3

Outwash Area ~~Waste Rock Pile No.2~~ Survey Line No. OA-7

Start GPS ______ ______

End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	482			27	27 —
	490			31	30
	500			30	29
	510			25	23
	520			22	21
	530			22	26
	540			22	24
	550			23	22
	560			20	21
	570			24	28
	580 (OA-7 END @ 577)			29	29

Survey Date 7/8/04 Personnel MTW / GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

3/3

Outwash Area Survey Line No. OA-8
26 Start GPS N700185.149 E2062328.691 meters
21 End GPS N700174.871 E2062489.641

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			26	26
	10			25	25
	20			27	26
	30			24	27
	40			27	27
	50			28	27
	60			26	25
	70			25	27
	80			27	28
	~~90~~ 90			26	25
	~~98~~ 98			24	27 Spring Flow
	110			29	25
	120			28	28
	130			25	25
	140			24	24
	150			25	24
	160			25	25
	170			20	21
	180			25	25
	190			24	22
	200			22	20
	210			22	24
	220			22	22
	230			24	23

Survey Date 7/8/04 Personnel GPM/MTW
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/3

Outwash Area Survey Line No. OA-8
Start GPS ______________ ______________
End GPS ______________ ______________

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			23	23
	~~250~~ 248			23	24 SPRING FLOW
	260			25	24
	270			22	22
	280			25	22
	290			22	22
	300			22	22
	310			25	23
	320			25	25
	330			25	27
	340			60	50
	350			50	45
	360			22	25
	370			22	26
	380			26	29
	390			37	34
	400			32	29
	410			22	25
	420			29	29
	430	(437 = ℄ SN33)		25	26
	440			22	24
	450			41	34
	460			65	40
	470			24	24

Survey Date 7/8/04 Personnel MTW /GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

2/3

Outwash Area Survey Line No. OA-8
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	480			22	22
	490			21	24
	500			22	19
	510			21	20
	520			19	20
	530			19	26
	540			21	21
	550			22	21
	560 (OA-8 END)			28	28

Survey Date 7/8/04 Personnel MTW / GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

3/3

Outwash Area Survey Line No. OA-9

25Start GPS N 700 210.467 E 2062338.176 meters

22End GPS N 700 203.431 E 2062496.835

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			22	22
	10			21	21
	20			21	21
	30			19	20
	40			19	21
	50			19	18
	60			20	20
	70			22	21
	80			20	19
	90			20	20
	100			20	20
	110			22	23
	120			21	22
	130			22	21
	140			21	22
	150			20	20
	160			23	22
	170			22	23
	180			23	21
	190			20	21
	200			22	23
	210			21	21
	220			26	25
	230			24	22

Survey Date 7/8/04 Personnel MTW/GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/3

Outwash Area Survey Line No. OA-9
Start GPS ______ ______
End GPS ______ ______

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			23	23
	250			22	22
	260			21	23
	270			21	21
	280			25	26
	290			24	25
	300			20	20
	310			~~25~~ 20	21
	320			23	23
	330			23	21
	340			20	20
	350			20	21
	360			22	23
	370			22	22
	380			22	27
	390			65	45
	400			65	60
	410			25	32
	420			41	33
	430			25	29
	440	(436 = ℄ OF SN 33)	(OUTSIDE GATE	30	28
	450			24	25
	460			23	23
	470			23	23

Survey Date 7/8/04 Personnel MTW/GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

2/3

Outwash Area Survey Line No. OA-9
Start GPS ____________ ____________
End GPS ____________ ____________

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	480			24	28
	490			20	21
	500			18	17
	510			17	17
	520			18	18
	530			19	18
	540			18	18
	550 (OA-9 END 555)			16	18

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

3/3

Outwash Area Survey Line No. OA-10

24 Start GPS N700 243.079 E2062336.367 METERS

23 End GPS N700 228.383 E2062504.738

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	0			16	17
	10			16	15
	20			15	14
	30			18	18
	40			19	18
	50			18	16
	60			18	18
	70			18	17
	80			20	20
	90			19	20
	100			20	19
	110			19	20
	120			20	18
	130			18	19
	140			20	20
	150			20	20
	160			19	21
	170			18	18
	180			17	17
	190			19	21
	200			20	19
	210			19	18
	220			20	~~20 16~~ 20
	230			20	16

Survey Date 7/8/04 Personnel MTW / GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

1/3

Outwash Area Survey Line No. OA-10
Start GPS ____________ ____________
End GPS ____________ ____________

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	240			19	20
	250			20	21
	260			19	20
	270			20	20
	280			18	19
	290			18	18
	300			20	19
	310			23	21
	320			23	20
	~~330~~ 330			20	19
	340			20	19
	350			19	20
	360			20	20
	370			21	20
	380			24	23
	390			20	20
	400			20	21
	410			22	23
	420			20	22
	430 (SN33 ℄)			25	25
	440			20	20
	450			20	22
	460			28	27
	470			46	44

Survey Date 7/8/04　　Personnel MTW/GPM
GPS Datum NAD 83 CSP ZONE 3　　Equipment LUDLUM MODEL 3 SURVEY MTR

2/3

Outwash Area Survey Line No. OA-10
Start GPS ____________ ____________
End GPS ____________ ____________

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
	480			55	50
	490			55	47
	500			25	26
	510			20	21
	520			19	18
	530			18	17
	540			18	18
	550			20	17
	560 (OA-10 END @ 565)			19	17

Survey Date 7/8/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

3/3

TETRA TECH EM INC

JUNIPER MINE *NEED CHAIN SAW FOR SNAGS/DOWN TIMBER

PHOTOGRAPH LOG

6/24/04

Camera ID: Juniper #1 Photographer: MATT UDELL

Picture Number	Date	Time	Direction Facing	Description
27	6/24/04	1800	N	Standing at camping area looking up road to SN84Y unofficially Top
26	↓	1805	NE	100 FT UP ROAD; (FENCE & SIGN R&R RQD)
25		1807	NW	CORNER @ END OF FIRST LONG UPHILL SECTION
24		1810	NW	SNAG MATERIAL & 3FT HIGH DIRT BERM
23		1812	W	FALLEN TREE TO CUT PRIOR TO SWITCHBACK
22		1813	W	LOOKING AROUND SWITCHBACK TO WEST
21		1817	S-SE	CLEARANCE ISSUE W/ SNAG & STUMP (LFT OF ROAD)
20		1820	E-SE	" " TALL TREES ON RT. (2) & LFT (1)
19		1826	W-NW	EXPLORATORY CUTS
18		1826	W-NW	" "
17		1828	S	SHARP CURVE W/ TREES (SOUTH OF EXP CUTS)
16		1835	E	PIT FLOOR
15		1835	E	SOUTH PIT WALL
14		1835	E	NORTH PIT WALL
13		1835	E	START OF PIT CREEK & WR2 (HUMMOCKY AREA)
12		1837	E	WR2 @ BASE OF PIT W/ REDROCK MEADOW BEHIND
11		1850	N-NW	UPGRADIENT WELL DRILL PAD
10		1850	E-SE	ACCESS ROAD UP TO PAD
9	↓	1852	E	LOG TO BE REMOVED FROM UPPERMINE ACCESS RD TO ACCESS DRILL PAD ROAD
~~8~~	~~6/29/04~~	~~0915~~	~~S~~	~~PC-1~~ MW
7	6/29/04	0916	S	~~PC-2~~ PC-3
6		0917	S	~~PC-3~~ PC-4
5		0918	S	~~PC-4~~ PC-5
4		0919	S	UC-3
3		0929	S	UC-4
2	↓	1015	S	UC-5
1	6/29/04	1045	S	UC-6
		~~10~~	~~S~~	~~UC-7~~ e MU

TETRA TECH EM INC

JUNIPER MINE
PHOTOGRAPH LOG

Camera ID: Juniper #2 Photographer: mtw

Picture Number	Date	Time	Direction Facing	Description
	~~1050~~			
27	6/29/04	1050	S	UC-7
26	6/29/04	1110	SE	UC-8
25	6/29/04	1122	SE	UC-9
24	6/29/04	1134	E	UC-10
23	6/29/04	1143	E	UC-11
22	6/29/04	1152	W	UC-12
21	6/29/04	1320	N	M-4
20	6/29/04	1403	NW	LC-5
19	6/29/04	1433	NW	LC-3
18	6/29/04	1500	NW	LC-4
17	6/29/04	1700	S	M-5
16		1710	S	M6
15		1740	SE	M7
14		1800	SE	M8
13		1830	NW	M9
12		1900	SE	M10
11		1900	SE	M 11
10		1925	S	M12
9		1940	S	M13
8	6/29/04	1951	~~N~~ SW	M14
7	6/29/04	2022	N	ALPEN GLOW
6	6/30/04	1330	N/A	WR3-1 EXCAVATION CUTTINGS
5		1335		WR3-1 EXCAVATION
4		1450		WR3-2 EXCAVATION
3		1451		WR3-2 EXCAVATION CUTTINGS
2	6/30/04	1805	N/A	WR3-3 " " & HOLE
~~1~~	~~6/30/04~~	~~1808~~	~~N/A~~	~~WR3-3 EXCAVATION~~ e (MTW)
1	7/1/04	1055	SW	SL-UB-2

TETRA TECH EM INC

JUNIPER MINE
PHOTOGRAPH LOG

Camera ID: JUNIPER #3

Photographer: MTW/GAM

	Picture Number	Date	Time	Direction Facing	Description
25	27	7/1/04	1905	W	SL-Bm
24	26	7/6/04	142φ	NA	LC4 TRANSECT SEDIMENT LOCATION (07/06/φ4-LC-SED-C)
23	25	7/6/04	15φ6	NA	M6 TRANSECT SEDIMENT LOCATION (φ7/φ6/φ4-MM-SED-C)
22	24	7/6/04	1555	NE	M14 " " " (φ7/φ6/φ4-UM-SED-C)
21	23	7/6/φ4	1655	E	UC-3 " " " (φ7/φ6/φ4-UC-SED-C)
20	22	7/7/04	1140	S	FLOW MEASUREMENT AREA 102' DOWNSTREAM OF LC-3
19	21	7/7/04	1142	N	LC2-W-6, 24' DOWN STREAM OF LC-3
18	20	7/7/04	1245	—	STREAM FLOW MEASUREMENT AREA (16' UPSTREAM OF M-6)
17	19	7/7/04	1246	~N	OVERALL SAMPLING (WATER) LOCATION (16' UPSTREAM OF M 6)
16	18	7/7/04	14φ4	—	STREAM FLOW MEAS. AREA (62' UPSTREAM OF UC-12)
15	17.	7/7/04	14φ5	~N	WATER SAMPLING AREA (" " " ")
			CAMERA		BROKEN

TETRA TECH EM INC

JUNIPER MINE
PHOTOGRAPH LOG

Camera ID: JUNIPER #4 | Photographer: MTW/GPM

Picture Number	Date	Time	Direction Facing	Description
27	7/7/04	1510	W	PCI
26		1515	NA	gorgs Pocket
25		1535	W	WR2
24		1710	N	BUC-sed-C
23		1745	N	7/6/04-UC-SED-C
22		1748	–	7/7/04-UC1-W-G-FLOW MEAS. LOC.
21		1825	S	7/7/04-WR1-W-G-F samp location
20		1900	S	7/7/04-BS-W-G-F spring sample loc.
19	7/8/04	1743	S	OA-5 TRANSECT
18				Down Road to Creek top
17				Up creek
16				Up wash and side drain
15				Down Road to Creek Botom
14				Rip Rap on Creek UWC
13				FLAT SED HOT PAN
12				FLAT Bed SHALLOW
11				~~Creek~~ 3' "
10				Creek
9				Drop at Creek

PHOTO LOG
~~Floodplain Perimeter Survey~~

Photographer: GRM

~~Stream Reach~~ PICTURE #/DATE	DIRECTION	~~Northing~~ DESCRIPTION	~~Easting~~
27 9/26/04	S	HAIL STORM DURING	MW-1 SURGE/BAIL
26 10/1/04	E	RAINBOW	

Survey Date ______________________ Personnel ______________________
GPS Datum ______________________ Equipment ______________________

Pit Creek Survey Line No. PC-3
Start GPS 699864.483 2062374.758 mters
End GPS 699854.817 2062370.359

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
2	3	35	34
3	6	32	~~34~~ 37
4	9	35	35
5	12	37	40
6	15	55	42
7	18	60	47
8	21	50	40
9	24	41	40
10	27	42	41
11	30	39	37
12	33	42	38
13	36	32	33
~~14~~	~~39~~		
1	0	35	35

Survey Date 6/28/04
GPS Datum NAD 83 SPC ZONE 3
Personnel MTW | GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

Pit Creek Survey Line No. PC-4
Start GPS 699 857.571 2062389.492 meters
End GPS 699 847.532 2062387.445

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	~~30~~ 34	~~30~~ 33
2	3	35	36
3	6	37	35
4	9	37	38
5	12	42	39
6	15	45	43
7	18	49	41
8	21	45	40
9	24	44	40
10	27	36	35
11	30	35	36
12	33	34	34
13	36	30	30

Survey Date 6/28/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW | GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

Pit Creek Survey Line No. PC5
Start GPS 699853.265 2062415.034 meters
End GPS 699842.944 2062415.601

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	31	32
2	3	33	31
3	6	34	32
4	9	30	32
5	12	32	33
6	15	49	40
7	18	48	40
8	21	55	39
9	24	39	39
10	27	34	32
11	30	29	29
12	33	28	29
13	36	27	27

Survey Date 6/28/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW | GPM
Equipment LUDLUM MODEL 3 SURVEY MTR.

Pit Spring
~~Sediment Basin Survey~~

~~Road~~

Point Name	Description	Northing	Easting	
~~33-1~~	Pit Spring	699984.499	2062216.335	2595.18

Survey Date ____________ Personnel ____________
GPS Datum ____________ Equipment ____________

Radiation Screening Sheet

Site Name: Juniper Mine
Date: 9/9/04
Personnel: Brad Shelton

Measurement Equipment Information:
Make:
Model Number:
Serial Number:
Check Source Reading:

Description (equipment, feature, material, etc.)	Location	Pre-Construction Measurement (µR/Hour)	Post Construction Measurement (µR/Hour)
Support Vehicle	Decon Pad	50 to 80	40 - 70
Drill Rig	Setup on MW-1	10 to 20	40 - 50*

Note: * on decon pad, levels are background

µR/hr = microRoentgen per hour

100 ft spacing
Min 50 ft long
Total of 10 transects

Red Rock Creek Canyon Survey Line No. UC-3
Start GPS N 699856.658 E 2062434.082 meter
End GPS N 699846.570 E 2062435.907

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
~~SC-3~~ nw			
Mw ~~1~~			
1	0	34	34
2	3	32	34
3	6	32	34
4	9	36	33
5	12	35	36
6	15	40	34
7	18	38	38
8	21	41	39
9	24	47	44
10	27	49	41
11	30	43	41
12	33	38	40
13	36	37	37
14	39	36	37
15	42	39	34
16	45	34	32

Survey Date 6/28/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY METER

Red Rock Creek Canyon Survey Line No. UC-4
Start GPS N 699859.910 E 2062458.034
End GPS N 699849.791 E 2062479.021 meters

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	35	33
2	3	34	36
3	6	35	35
4	9	34	33
5	12	27	30
6	15	29	28
7	18	28	30
8	21	25	32
9	24	29	31
10	27	28	32
11	30	32	33
12	33	32	33
13	36	30	33
14	39	34	35
15	42	42	37
16	45	40	37
17	48	42	37
18	51	32	32
19	54	30	31
20	57	30	31
21	60	31	30
X Creek center	@ 44'		

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW, GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

Red Rock Creek Canyon Survey Line No. UC-5
Start GPS N 699878.662 E 2062477.970 meter
End GPS N 699862.220 E 2062492.791

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	37	34
2	3	35	34
3	6	40	37
4	9	40	39
5	12	40	37
6	15	43	38
7	18	42	40
8	21	37	38
9	24	37	37
10	27	42	38
11	30	45	42
12	33	45	40
13	36	43	42
14	39	47	39
15	42	42	39
16	45	38	38
17	48	37	37
18	51	39	38
19	54	35	37
20	57	35	37
21	60	50	39
22	63	41	39
23	66	41	37
24	69	42	34
25	72	29	31
26	75	29	29
* Stream @	45'		

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel mtw, gpm
Equipment mod 3 survey meter

nr

Red Rock Creek Canyon Survey Line No. UC-6
Start GPS N 699891.303 E 2062510.933 meters
End GPS N 699876.603 E 2062512.679

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	38	37
2	3	40	39
3	6	41	39
4	9	41	37
5	12	38	37
6	15	44	38
7	18	39	36
8	21	39	37
9	24	48	37
10	27	43	38
11	30	39	38
12	33	41	38
13	36	43	39
14	39	42	38
15	42	39	39
16	45	34	35
17	48	32	33
18	51	33	33
* Stream @	31'		

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel mtw, gpm
Equipment mod 3 recorder

hr

Red Rock Creek Canyon Survey Line No. UC-7
Start GPS N 699914.692 E 2062531.229 meters
End GPS N 699903.103 E 2062540.101

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	~~0~~ 0	42	39
	3	39	35
	6	37	35
	9	40	37
	12	31	34
	15	44	34
	18	42	35
	21	34	33
	24	32	32
	27	30	30
	30	25	27
	33	27	29
	36	29	28
	39	34	30
	42	30	29
	45	30	31
	48	31	31
	51	33	31
* crek @	35		

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel mtw, gpm
Equipment LUDLUM MODEL 3 SURVEY MTR

Red Rock Creek Canyon Survey Line No. UC-8
Start GPS N 699934.803 E 2062550.354 meters
End GPS N 699925.227 E 2062562.109

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	38	32
	3	45	34
	6	37	33
	9	32	32
	12	30	30
	15	33	29
	18	30	30
	21	22	26
	24	26	27
	27	27	27
	30	29	27
	33	30	29
	36	34	26
	39	26	26
	42	29	30
	45	29	26
	48	28	27
	51	27	25
* CREEK @ 26'			

Survey Date 6/29/04
GPS Datum NAD 83 CCP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR.

Red Rock Creek Canyon Survey Line No. UC-9
Start GPS N 699955.279 E 2062568.392 meters
End GPS N 699947.986 E 2062581.004

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	39	34
	3	40	37
	6	40	34
	9	38	36
	12	37	35
	15	35	32
	18	39	34
	21	29	29
	24	28	29
	27	29	29
	30	37	31
	33	33	33
	36	35	33
	39	39	33
	42	37	34
	45	34	30
	48	30	29
	50	28	27
*CREEK @ 24'			

(BELOW DRAINAGE SWALE FROM WR 2 (NEAR MIDPT))

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel GPM/MTW
Equipment MODEL 3 SURVEY METER

Red Rock Creek Canyon Survey Line No. UC-10
Start GPS N 699957.695 E 2062601.651 meters
End GPS N 699954.656 E 2062608.775

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	31	29
	3	35	29
	6	36	31
	9	37	31
	12	35	30
	15	32	28
	18	28	28
	21	24	26
	24	29	22
	27	22	25
	30	25	22
	33	20	20
	36	21	21
	39 @ STACK ABOVE BANK	—	—
CREEK ℄ 18' & 26' w/ ISLAND			

@ CREEK CORNER/ HIGH CUT BANK

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel WTW / GPM
Equipment LUDLEM MODEL 3 SURVEY MTR.

Red Rock Creek Canyon Survey Line No. UC-11
Start GPS N 699998.096 E 2062604.422
End GPS N 699992.948 E 2062609.329 meters

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	22	24
	3	23	23
	6	24	25
	9	24	26
	12	32	34
	15	28	29
	18	38	32
	21	35	32
	24	25	25
	27	24	26
* CREEK @ 13.5'			

(JUST ~~PAST~~ OUTSIDE FENCE LINE)

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR.

Red Rock Creek Canyon Survey Line No. UC-12
Start GPS N ~~7000~~ 699998.413 E 2062642.232 meters
End GPS N 699996.813 E 2062634.250

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	25	25
	3	27	26
	6	25	27
	9	27	26
	12	25	28
	15	28	26
	18	30	31
	21	35	30
	24	28	26
	27	28	28
	30	26	26
	33	25	24
	36	25	26
CREEK ℄ 12'			

(JUST PRIOR TO GRANITE OUTCROP)

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel WTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR.

699998.5
-17
x 8

Red Rock Creek Lower Meadow Survey Line No. SL-CC5
Start GPS 7ϕϕ 143.712 2ϕ63464.742
End GPS 7ϕϕ188.036 2ϕ63444.372 meters

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	20	20
	3	20	19
	6	20	20
	9	19	19
	12	19	19
	15	20	19
	18	20	19
	21	19	19
	24	19	19
	27	18	19
	30	19	19
	33	18	18
	36	19	18
	39	20	19
	42	18	19
	45	19	18
	48	19	20
	51	19	19
	54	19	21
	57	20	19
	60	23	21
	63	21	21
	66	22	19
	69	20	19
	72	20	20
	75	23	20
	78	28	24
	81	31	28
	84	31	28
	87	27	26
	90	26	27
	93	27	24
	96	28	25
	99	26	23
	102	19	21
	105	26	22
	108	23	23
	111	28	22
	114	26	25
	117	26	24

* CRK CL 101'; WET MARSH 108'-145'

Red Rock Creek Lower Meadow Survey Line No. SL-LC5
Start GPS ____________ ____________
End GPS ____________ ____________

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	120	21	21
	123	22	23
	126	20	22
	129	23	21
	132	23	21
	135	23	21
	138	22	24
	141	21	19
	144	19	18
	147	10	18
	150	17	13
	153	17	17
	156	17	15
	159	16	17

Survey Date 6/29/04 Personnel MTW/GPM
GPS Datum NAD83 CSP Zone 3 Equipment LUDLUM MODEL 3 SURVEY MTR.

Every 500'   150' Transect Min

Red Rock Creek Lower Meadow Survey Line No. SL-LC3
Start GPS 700179.055   2063529.624 meters
End GPS 700204.698   2063498.928
(READING 2m S. OF STAKE)

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	20	20
	3	21	20
	6	21	21
	9	19	20
	12	20	20
	15	21	20
	18	23	20
	EDGE OF CREEK BED — 21	19	24
	24	28	25
	27	26	24
	30	20	21
	33	27	26
	36	27	24
	39	27	25
	42	20	22
	45	22	20
	48	20	20
	51	19	19
	54	20	19
	57	20	21
	60	20	21
	63	22	22
	66	22	20
	69	20	20
	72	20	19
	75	22	21
	78	20	20
	81	19	19
	84	19	19
	87	19	18
	90	21	19
	93	19	19
	96	21	20
	99	20	18
	102	20	20
	105	19	19
	108	19	18
	111	19	21
	114	19	18
	117	17	18

CREEK ℄ 30'   MARSH 117' – 81'

Red Rock Creek Lower Meadow Survey Line No. SL-LC3
Start GPS ____________ ____________
End GPS ____________ ____________

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	120	19	17
	123	19	19
	126	18	17
	129	16	18
	132	17	16
	135	19	18
	138	19	17
	141	18	20
	144	17	19
	147	19	19
	150	19	19

Survey Date 6/29/09 Personnel MTW/GPM
GPS Datum NAD 83 CSP Zone 3 Equipment Ludlum Model 3 Survey Mtr

Red Rock Creek Lower Meadow Survey Line No. SL-LC4
Start GPS TO FEW SATELITES
End GPS 740255.931 2063554.970 (150' SE TO START) meters

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	21	20
	3	20	22
	6	21	23
	9	19	20
	12	21	20
	15	20	20
	18	21	20
	21	19	22
	24	20	20
	27	20	20
	30	23	21
	33	21	22
	36	24	23
	39	28	25
	42	~~32~~ 28	28
	45	23	25
	48	22	21
	51	23	24
	54	21	21
	57	21	20
	60	19	20
	63	21	21
	66	20	20
	69	20	19
	72	18	17
	75	18	19
	78	16	19
	81	17	17
	84	16	17
	87	15	16
	90	15	16
	93	16	15
	96	16	17
	99	16	16
	102	17	16
	105	17	15
	108	17	15
	111	14	16
	114	17	16
	117	15	15

CREEK ℄ 99'

Red Rock Creek Lower Meadow Survey Line No. SL-LC 4
Start GPS ____________ ____________
End GPS ____________ ____________

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	120	15	15
	123	15	15
	126	16	14
	129	15	14
	132	16	15
	135	14	15
	138	14	16
	141	15	15
	144	15	15
	147	16	14
	150	15	15

Survey Date 6/29/04 Personnel MTW / GPM
GPS Datum NAD83 CSP Zone 3 Equipment LUDLUM MODEL 3
SURVEY MTR

Red Rock Creek Middle Meadow Survey Line No. SL-M7
Start GPS ~~700~~ 699988.316 2063190.261 meters
End GPS 700007.261 2063167.240

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	20	20
2	3	21	19
3	6	20	20
4	9	19	19
5	12	19	19
6	15	19	19
7	18	20	20
8	21	19	21
9	24	20	19
10	27	20	21
11	30	22	20
12	33	27	23
13	36	nr	nr
14	39	nr	nr
15	42	20	24
16	45	26	24
17	48	30	26
18	51	30	28
19	54	30	27
20	57	33	29
21	60	30	26
22	63	26	26
23	66	27	25
24	69	25	25
25	72	25	25
26	75	25	24
27	78	23	23
28	81	22	22
29	84	25	22
30	87	20	21
31	90	20	21
32	93	19	20
33	96	20	20
34	99	21	20
35	102	21	20
~~36~~			
Stream @	39'		

Survey Date 6/24/04 Personnel hw, gm
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

Red Rock Creek Middle Meadow Survey Line No. SL-M6 (ONLY 5Ø') Transect picking up signal ≥ 35-40 uR/hr
Start GPS 700054.340 2063206.362 meters
End GPS 700066.386 2063197.218

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	22	20
2	3	21	20
3	6	20	21
4	9	24	22
5	12	26	24
6	15	30	25
7	18	30	28
8	21	34	29
9	24	34	30
10	27	33	30
11	30	36	32
12	33	34	28
13	36	24	24
14	39	25	24
15	42	24	24
16	45	22	24
17	48	22	24
18	51	21	20
~~19~~	~~5~~		
~~20~~			
Stream @	36'		

Survey Date 6-29-04 Personnel MTW/GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

Red Rock Creek Middle Meadow Survey Line No. SL-M5
Start GPS 700074.780 2063252.540 meters
End GPS 700101.327 2063265.036

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	19	18
2	3	19	20
3	6	20	20
4	9	20	19
5	12	20	18
6	15	19	19
7	18	21	21
8	21	21	21
9	24	21	20
10	27	21	20
11	30	21	20
12	33	22	22
13	36	23	23
14	39	25	22
15	42	22	22
16	45	22	21
17	48	20	22
18	51	24	23
19	54	23	24
20	57	24	22
21	60	23	22
22	63	23	22
23	66	22	23
24	69	22	21
25	72	23	20
26	75	22	22
27	78	22	22
28	81	20	20
29	84	23	20
30	87	21	21
31	90	22	20
32	93	20	19
33	96	20	19
34	99	19	18
Creek @ 47			

Survey Date 6/29/04
Personnel htw gpm
GPS Datum NAD 83 CSP Zone 3
Equipment Ludlum Model 3 Survey Mtr

250 ~~500~~' apart

100' long Transects Min.

Red Rock Creek Middle Meadow Survey Line No. SL – M4

Start GPS 700049.957 2063335.070

End GPS 700081.863 2063332.615 > meters

Rad End
1. Transect Length
2. Stake/label
3. GPS
4. Mark map
5. flag

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	16	16
	3	19	19
	6	20	20
	9	18	18
	12	18	18
	15	19	17
	18	19	18
	21	~~19~~ 21	~~18~~ 19
	24	21	20
	27	19	19
	30	21	20
CREEK BED	33	20	19
	36	24	22
	39	28	22
	42	25	25
	45	29	25
	48	25	26
	51	28	26
	54	29	28
	57	24	24
	60	24	25
	63	26	25
	66	25	25
	69	23	24
	72	24	23
	75	25	24
	78	28	27
	81	29	26
	84	25	24
	87	24	22
	90	20	20
	93	19	18
	96	20	18
	99	19	20
	102	19	19
	105	19	17
* CREEK ℄ 28'			

Survey Date 6/29/04 Personnel MTW/GPM

GPS Datum NAD83 CSP Zone 3 Equipment LUDLUM MODEL 3 SURVEY MTR

Upper

Red Rock Creek ~~Middle~~ upper Meadow Survey Line No. SL-MJ4
Start GPS 699982.719 2062734.956 meters
End GPS 699993.174 206 2726.140

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	23	23
	3	22	23
	6	23	23
	9	21	21
	12	23	20
	15	22	23
	18	22	22
	21	23	25
	24	27	23
	27	27	26
	30	25	24
	33	25	24
	36	24	24
	39	20	20
	42	21	20
	45	20	17
	48	21	21
CREEK @ 32'			

Survey Date 6/29/04 Personnel MTW / GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment LUDLUM MODEL 3 SURVEY MTR

upper

Red Rock Upper Meadow Survey Line No. SL-M13
Start GPS 699976.110 2062778.733 meters
End GPS 699955.199 2062776.885

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	21 24	18 23
	3	20 26	21 24
	6	21 22	18
	9	20	20
	12	21	20
	15	21	21
	18	20	20
	21	20	20
	24	21	20
	27	20	20
	30	20	23
	33	22	23
	36	22	22
	39	24	24
	42	27	25
	45	28	27
	48	28	25
	51	28	25
	54	26	25
	57	26	24
	60	24	23
	63	23	26
	66	32	27
	69	27	25
	72	26	24
	75	24	23
X CREEK @ 60'			

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR.

upper

Red Rock Upper Meadow Survey Line No. SL-M12
Start GPS 699910.181 2062847.711
End GPS 699885.417 2062848.050 meters

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	17 17	17 17
	3	19 18	19 17
	6	19 19	19 18
	9	17 24	19 22
	12	18 28	18 28
	15	20 31	20 28
	18	17 30	17 28
	21	19 23	18 25
	24	20 24	20 24
	27	18	20
	30	20	21
	33	18	22
	36	25	25
	39	28	27
	42	26	25
	45	27	27
	48	25	23
	51	21	23
	54	20	24
	57	24	24
	60	23	25
	63	30	28
	66	31	28
	69	28	25
	72	24	22
	75	19	18
	78	18	17
	81	17	17
*CREEK @ 54'			

Survey Date 6/29/04
GPS Datum NAD83, CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

upper

Red Rock Upper Meadow Survey Line No. SL-M11
Start GPS 699 908.560 2062916.852 ← 1.5 m North of Post
End GPS 699 887.303 2062928.174

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	19	17
	3	20	18
	6	17	18
	9	19	17
	12	18	19
	15	19	20
	18	25	23
	21	27	25
	24	28	23
	27	19	21
	30	22	24
	33	32	26
	36	31	27
	39	26	23
	42	23	21
	45	25	24
	48	27	26
	51	24	24
	54	22	20
	57	18	19
	60	17	15
	63	17	18
	66	18	18
	69	16	18
	72	16	16
	75		
	78		
	81		
	84		
	87		
	90		
	93		
	96		
	99 e 72		

* CREEK @ 40'
Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MATW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

upper

Red Rock Upper Meadow Survey Line No. SL-M10 Next of SL-M2
Start GPS 699943.273 2062971.615 meters
End GPS 699913.264 2062961.064

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	16	17
2	3	16	16
3	6	17	19
4	9	19	18
5	12	18	17
6	15	19	18
7	18	18	19
8	21	18	18
9	24	18	19
10	27	20	20
11	30	21	22
12	33	20	22
13	36	22	24
14	39	31	26
15	42	34	30
16	45	37	30
17	48	36	30
18	51	34	28
19	54	32	29
20	57	35	27
21	60	31	25
22	63	31	28
23	66	29	28
24	69	28	27
25	72	31	26
26	75	30	28
27	78	33	31
28	81	31	27
29	84	29	27
30	87	26	24
31	90	25	25
32	93	33	27
33	96	26	26
34	99	21	20
35 Stream @ 35	102	19	19
	105	20	19
	108	19	18

Survey Date 6/29/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

upper

Red Rock Upper Meadow Survey Line No. SL-M9
Start GPS 699 967.650 2063034.939 meters
End GPS ~~699945~~ 699 2063036.754

Point is 25 ft East of GPS pt. (Trees)

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	18	18
2	3	18	18
3	6	mw ~~18~~ 16	17 ~~16~~ mw
4	9	17	18
5	12	19	18
6	15	20	19
7	18	20	20
8	21	22	24
9	24	29	26
10	27	25	25
11	30	29	28
12	33	29	27
13	36	30	28
14	39	32	28
15	42	27	25
16	45	28	26
17	48	22	24
18	51	22	23
19	54	24	21
20	57	22	20
21	60	23	18
22	63	19	19
23	66	19	19
24	69	17	17
25	72	18	18
26	75	18	17
27	78	18	18
Stream splits @ 27' + 58'			

Survey Date 6/24/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

upper

75 ft Transect
250 spacing

Red Rock Upper Meadow Survey Line No. SL - M8
Start GPS 699923.782 2063117.302 meters
End GPS 699948.357 2063124.644

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
1	0	19	19
2	3	18	18
3	6	20	19
4	9	19	18
5	12	18	18
6	15	19	19
7	18	20	17
8	21	18	20
9	24	19	20
10	27	19	19
11	30	20	19
12	33	19	19
13	36	19	18
14	39	20	20
15	42	20	21
16	45	21	22
17	48	25	20
18	51	26	23
19	54	27	25
20	57	28	25
21	60	22	25
22	63	35	28
23	66	31	25
24	~~3~~69	25	24
25	72	22	21
26	75	22	21
27	78	22	20
28	81	20	21
29	84	20	19
30	87	19	20
CREEK @ 58'			

Survey Date 6/29/09
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

Red Rock Meadow Background Survey Line No. SL-BM

Start GPS 700170.418 2063221.308

End GPS 700185.843 2063162.077

200'
10' INTERVALS

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	18	18
	10	16	16
	20	20	16
	30	17	16
	40	16	16
	50	15	17
	60	16	15
	70	17	18
	80	17	16
	90	16	17
	100	18	16
	110	19	19
	120	17	16
	130	18	18
	140	16	18
	150	17	17
	160	18	18
	170	18	19
	180	17	18
	190	18	18
	200	19	17

Survey Date 7/1/04

GPS Datum NAD 83 CS1 ZONE 3

Personnel MTW / GAM

Equipment LUDLUM MODEL 3 SURVEY MTR

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location BUC-SED-C

Sample/Measurement Date 6/30/04

Sampling Team GPM/MTW

SEE SL-BUC; LOCATION COINCIDENT

Time	Sample Number	Sample Depth ~~(ft bgs)~~	Grab?	Northing	Easting	Metals	Rad uR/hr	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1535	BUC-SED	12"	Y	~4' S OF CRK ℄			17					
1540	BUC-SED	18"	Y	~6' N. OF CRK ℄			18					
1549	BUC-SED	Ø"	Y	IN CRK			16					
1552	BUC-SED	Ø"	Y	~3' N. OF CRK ℄			17					
1555	Ø6/3Ø/04-BUC-SED-C		N				—					

Observations RAINING DURING COLLECTION; COMPOSITE SED/SOIL WAS MOIST TO WET; SOME ORGANICS IN SOIL; LARGER GRAVELS REMOVED

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location: UC-SED-C @ UC-3 TRANSECT, 10' DOWN STREAM

Sample/Measurement Date: ϕ7/ϕ6/ϕ4

Sampling Team: MTW / GPM

Time	Sample Number	Sample Depth (ft bgs)	Grab?	Northing	Easting	Metals	Rad µR/hr	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1624	UC-SED-C	ϕ'	~~DRY~~ Y	℄ OF CRK			37					
1628	↓	1.ϕ'	Y	EAST SIDE			38					
1632		1.5'	Y	WEST SIDE	W/ IN 2-3'		44					
1637		ϕ'	Y	EAST SIDE	OF WATERS EDGE		4ϕ					
1640	UC-SED-C	ϕ.5'	Y	WEST SIDE			4ϕ					
1645	ϕ7/ϕ6/ϕ4-UC-SED-C		N				—					

Observations: WET SAMPLE, LARGER (1"-3" ϕ) GRAVELS REMOVED, TRACE ORGANICS, SANDY

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location UM -SED -C @ M14 INTERSECTION W/ CRK
Sample/Measurement Date Ø7/Ø6/Ø4
Sampling Team MTW / GPM

Time	Sample Number	Sample Depth (ft bgs)	Grab?	Northing	Easting	Metals	Rad uR/HR	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1530		Ø.5'	Y	WEST SIDE			26					
1534		Ø.75'	Y	WEST SIDE			26					
1538		1.0'	Y	EAST SIDE	W/ IN 3' OF CREEK EDGE		25					
1540		Ø	Y	WEST SIDE			26					
1543		1.5'	Y	EAST SIDE			26					
1545	Ø7/Ø6/Ø4-UM-SED-C	–	N				—					

Observations WET, TRACE ROOTLETS, SANDY ~~WELL GRADED SANDS~~, LARGER GRAVELS REMOVED

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location MM-SED-C @ MG TRANSECT ≈ ~~20'~~ 15' DOWNSTREAM
Sample/Measurement Date Ø7/Ø6/Ø4
Sampling Team MTW / GPM

Time	Sample Number	Sample Depth (ft bgs)	Grab?	Northing	Easting	Metals	Rad uR/hr	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1445	MM-SED	Ø	Y	EAST SIDE			29					
1447	MM-SED	1.5'	Y	WEST SIDE	W/IN 2' TO 3'		27					
1449	MM-SED	Ø	Y	" "	OF CRK EDGE		26					
1452	MM-SED	1.Ø	Y	EAST SIDE			27					
1455	MM-SED	Ø	Y	@ CRK CL			26					
15ØØ	Ø7/Ø6/Ø4-MM-SED-C	—	N				—					

Observations WET, W/ ROOTLETS, LARGER GRAVELS REMOVED

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location LC-SED-C @ LC-4 TRANSECT INTERSECTION W/ CRK

Sample/Measurement Date 07/06/04

Sampling Team MTW / GPM

Time	Sample Number	Sample Depth (ft bgs)	Grab?	Northing	Easting	Metals	Rad µR/HR	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
14ØØ	LC-SED	Ø	Y	@ CRK ℄			23					
14Ø4	LC-SED	Ø	Y	EAST SIDE	W/IN 2' OF ~~2@~~ WATERS EDGE		24					
14Ø8	LC-SED	1'	Y	WEST SIDE			25					
141Ø	LC-SED	1'	Y	WEST SIDE			25					
1415	07/06/04-LC-SED-C		N									

Observations SOME ORGANICS IN COMPOSITE, LARGER GRAVELS REMOVED, WET SAMPLE

STREAM PROFILE SHEET

Profile Location 07/07/04-UC1-V-G-F

Measurement Date and Time 7/7/04 1455

~~Staff Gage Elevation~~

GPS Location 28' DS of tran UC-3

Profile Width 24"

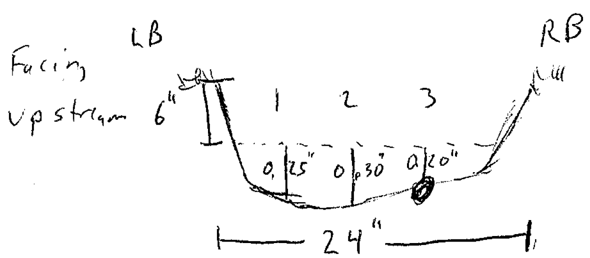
Number of Segments 4

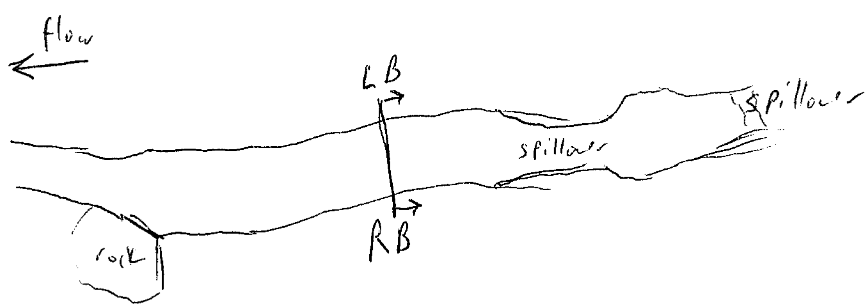
Width of Each Segment 6"

Observations (bank full, substrate covered, eddies, turbulent flow) Clean banks, 6" freeboard, spill over 2.5' upstream

Profile Sketch (Plan and Cross-Section)

X-sect





UCI-W-G

Segment Number 1

Segment Distance Begin/End to Left/Right Bank 6"

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	~~.02~~ 0.25	.02
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream		

Segment Number 2

Segment Distance Begin/End to Left/Right Bank 12"

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	~~.06~~ 0.30	.06
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream		

Segment Number 3

Segment Distance Begin/End to Left/Right Bank 18"

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	~~0.10~~ 0.20	0.10
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream		

STREAM PROFILE SHEET

Profile Location UC2-W-6

Measurement Date and Time 7/7/04 1350

~~Staff Gage Elevation~~

GPS Location 62' FT UPSTREAM OF UC-12

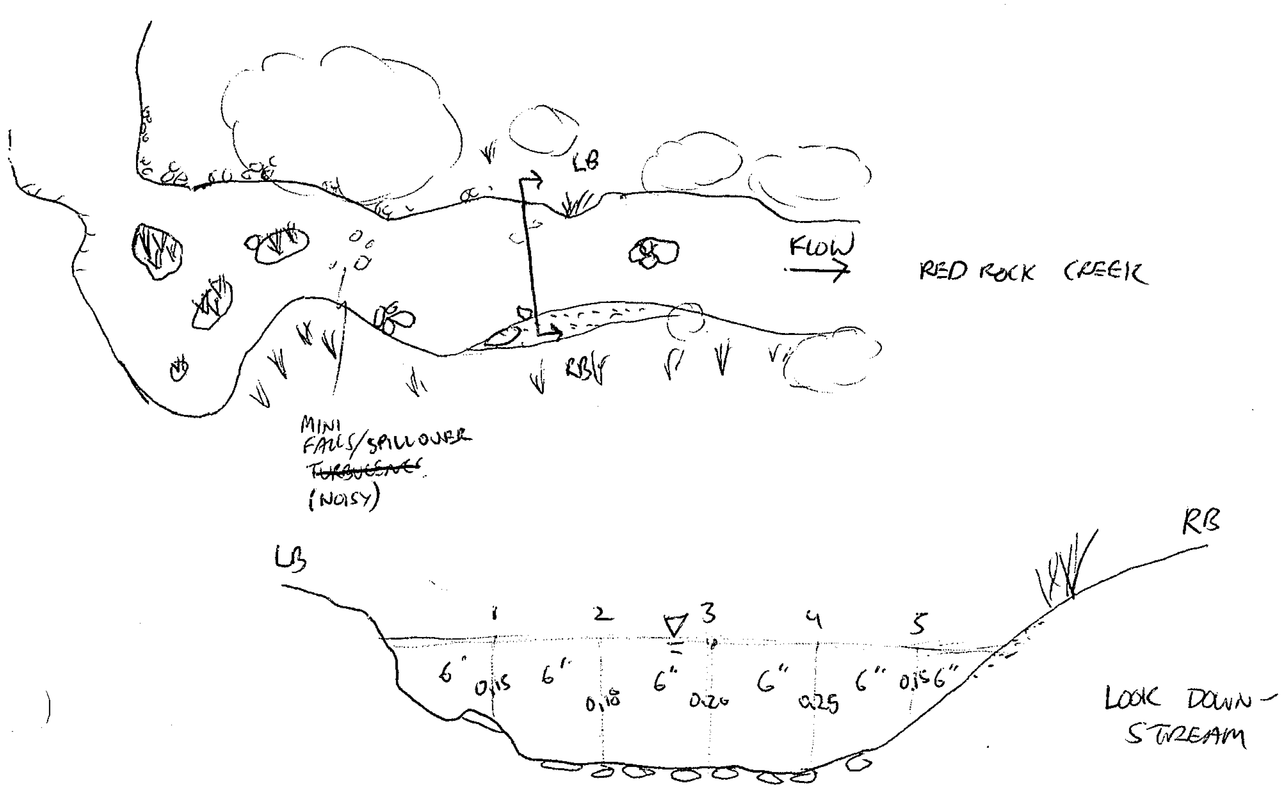
Profile Width 36"

Number of Segments 6

Width of Each Segment 6"

Observations (bank full, substrate covered, eddies, turbulent flow) ROCKY SUBSTRATE, SOME VISUAL ~~TURBULENCE~~ RIPPLES ON SURFACE DOWN STREAM OF SPILLOVER

Profile Sketch (Plan and Cross-Section)



UC2-W-G

Segment Number 1

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 6" 0.15' DEEP

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
→ Water Surface /BOTTOM	~~0.10~~ Ø	Ø.1Ø
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
WQ Bottom of Stream		

Segment Number 2

~~Segment Distance Begin/End to Left~~/Right Bank

Segment Distance to Left/Right Bank 12" Ø.18' DEEP

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
→ Water Surface / BOTTOM	Ø	Ø.6Ø
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
WQ Bottom of Stream		

Segment Number 3

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 18" Ø.26' DEEP

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
→ Water Surface /BOTTOM	Ø	1.22
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
WQ Bottom of Stream		

UC-2-W-6

Segment Number 4

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 24" 0.25' DEEP

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	0.25	~~0.57~~ 0.60
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream	~~0.25~~ 0	0.57

Segment Number 5

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 30" 0.15' DEEP

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	0	0.14
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream	~~0.15~~	~~NA~~

Segment Number

Segment Distance Begin/End to Left/Right Bank

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface		
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream		

STREAM PROFILE SHEET

Profile Location M2-W-6

Measurement Date and Time 7/7/04 1221

~~Staff Gage Elevation~~

GPS Location 16' UPSTREAM OF M-6

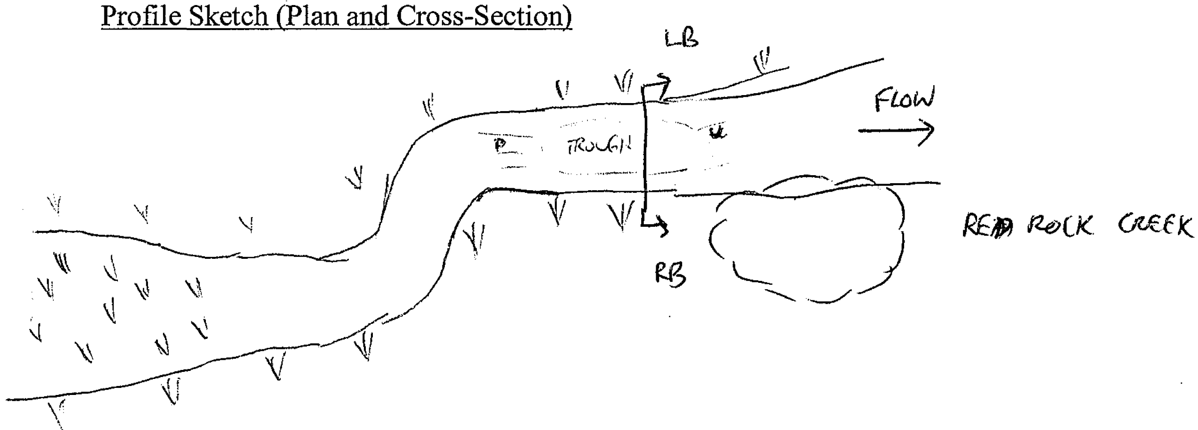
Profile Width 27"

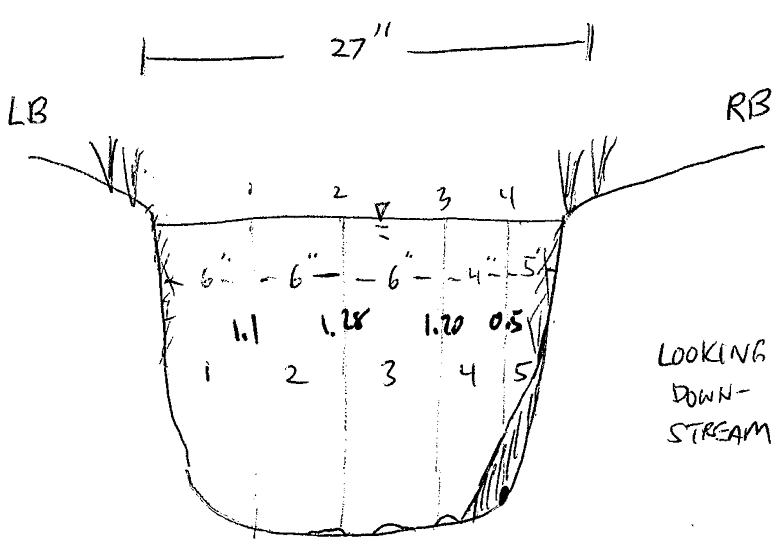
Number of Segments 5

Width of Each Segment ≈ 6" (SEE EXCEPTIONS)

Observations (bank full, substrate covered, eddies, turbulent flow) SUBSTRATE MOSTLY SILTS/ SEDIMENTS W/ SOME VISIBLE ROCKS @ BASE & ROOTLETS ON SIDE WALLS; DOWN STREAM FAR ENOUGH FROM "5" THAT FLOWS APPEARS SMOOTH/LAMINAR

Profile Sketch (Plan and Cross-Section)





m2-W-6

Segment Number 1

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 6"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	1.1'	0.06
0.8X Water Depth		
0.6X Water Depth	0.66	0.09
0.2X Water Depth		
Bottom of Stream	~~1.1'~~ 0.0	0.03

Segment Number 2

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 12"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	1.28	0.11
0.8X Water Depth		
0.6X Water Depth	0.77	0.07
0.2X Water Depth		
Bottom of Stream	0.0	0.27

Segment Number 3

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 18"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	1.20	0.12
0.8X Water Depth		
0.6X Water Depth	0.72	0.10
0.2X Water Depth		
Bottom of Stream	0.0	0.12

M2-W-6

Segment Number 4

~~Segment Distance Begin/End to Left/Right Bank~~ 22'

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	0.5	0.02
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream	0.0	0.01

Segment Number ~~5~~

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface		
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream	~~0.0~~	

Segment Number

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface		
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream		

STREAM PROFILE SHEET

Profile Location NEAR LC2 – W – G WHICH IS 23' DOWNSTREAM OF LC-3

Measurement Date and Time 7/7/04

~~Staff Gage Elevation~~

GPS Location @ LC-3 (102' DOWN STREAM)

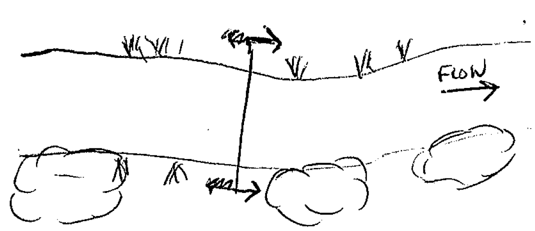
Profile Width 33"

Number of Segments ~~5~~ 6

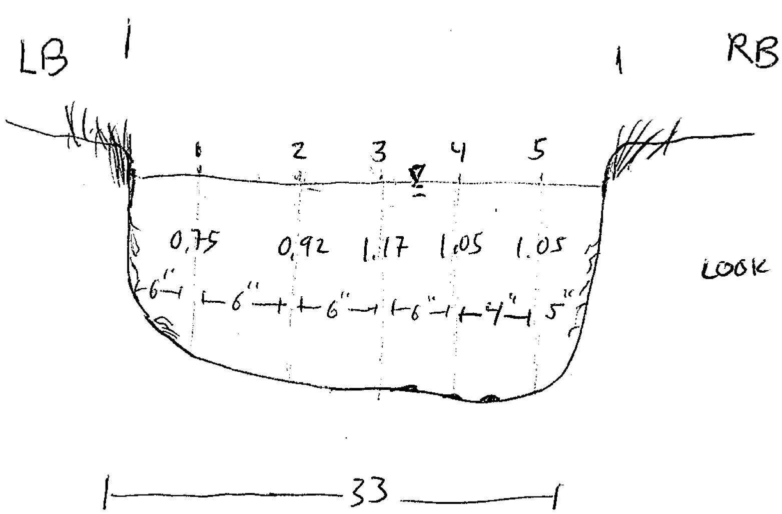
Width of Each Segment ≈ 6" (NOTE EXCEPTIONS @ RB)

Observations (bank full, substrate covered, eddies, turbulent flow) SUBSTRATE COVERED W/ SEDIMENTS/SOIL; MINOR ROOTLETS VISIBLE, NO VISIBLE EDDIES, FLOW APPEARS LAMINAR/SMOOTH, SURFACE OF A FEW ROCKS VISIBLE @ BASE

Profile Sketch (Plan and Cross-Section) $\xrightarrow{N}$



RED ROCK CREEK



LOOK DOWNSTREAM

LC2-W-G

Segment Number 1

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 6", 0.75' deep

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	0.75'	.07
0.8X Water Depth		
0.6X Water Depth	~~0.46~~ 0.45	0.08
0.2X Water Depth		
Bottom of Stream	0.~~75~~	0.03

if >2' depth

Segment Number 2

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 12"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	0.92	0.08
0.8X Water Depth		
0.6X Water Depth	0.55	0.17
0.2X Water Depth		
Bottom of Stream	0.0	0.05

Segment Number 3

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 18"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	1.17	0.11
0.8X Water Depth		
0.6X Water Depth	0.70	0.14
0.2X Water Depth		
Bottom of Stream	0.0	0.08

LCZ-W-G

Segment Number 4

~~Segment Distance Begin/End to Left/Right Bank~~

Segment Distance to Left/Right Bank 24"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	1.05	0.10
0.8X Water Depth		
0.6X Water Depth	0.63	0.06
0.2X Water Depth		
Bottom of Stream	0.0	0.13

Segment Number 5

~~Segment Distance~~ Begin/End to Left/Right Bank

Segment Distance to Left/Right Bank 28"

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface	1.05	0.09
0.8X Water Depth		
0.6X Water Depth	0.63	0.12
0.2X Water Depth		
Bottom of Stream	0.0	0.08

Segment Number

Segment Distance Begin/End to Left/Right Bank

Segment Distance to Left/Right Bank

Measurement Point	Distance from Bottom (ft)	Velocity (ft/sec)
Water Surface		
0.8X Water Depth		
0.6X Water Depth		
0.2X Water Depth		
Bottom of Stream		

JUNIPER MINE
WATER QUALITY MONITORING

Date: 7/7/04 **Calibration Code:** JUNIPER -07/07/04 **Personnel:** MTW / GPM

Location	Time	pH	ORP (mV)	Specific Cond. (µS/cm)	Temperature (C)	Dissolved Oxygen (mg/L)	Comments	Fe^{2+} mg/L
LC2-W-G	1050	7.12	84.0	113	11.26	10.70	@ LC-3 (24' DOWNSTREAM) 0.0	0.0
M2-W-G	1221	7.88	36.5	114	21.17	3.32	@ M-6	0.0
UC2-W-G	1350	7.81	71.3	116	19.84	2.02	NEAR UC-12 (62' UPSTREAM)	0.0
UC1-W-G	1455	8.49	72.3	255	20.22	3.70	@ CONFLUENCE OF RRC & PIT CRK	0.0
PC1-W-G	1530	8.57	74.1	409	21.30	2.97	PIT CREEK @ SN33 CROSSING / ≈ 105 gpm	0.0
WR2-W-G	1600	7.80	78.3	522	23.83	6.46	SEEP BELOW WR2	0.0
BUC-W-G	1710	7.46	225.7	68	13.11	3.95	@ BUC-Sed-C / ≈ 1.5 gpm	0.0
WR1-W-G	1800	6.92	272.7	222	8.60	4.32	spring / ≈ 2.0 gpm	0.0
W-BG-Spring	1845	7.44	212.6	232	11.46	4.71	pothole w/ trickle (< 500 ml/min)	0.0
PS-W-G	1920	7.43	262.2	393	7.21	3.87	pit spring	0.0

200' ft lng
10-foot readings

Upland Area Background Survey Line No. SL-UB 2
7 Start GPS N 699892.479 E 2062045.922
8 End GPS N 699854.601 E 2061998.925

Point Number	Distance from End	Surface (uR/hr)	3 foot (uR/hr)
	0	16	15
	10	15	14
	20	14	14
	30	15	13
	40	16	14
	50	15	14
	60	15	16
	70	15	15
	80	14	14
	90	14	14
	100	15	14
	110	15	15
	120	15	14
	130	13	15
	140	15	15
	150	15	16
	160	16	14
	170	17	15
	180	15	15
	190	16	17
	200	15	15

Survey Date 7/1/04
GPS Datum NAD 83 CSP ZONE 3
Personnel MTW / GPM
Equipment LUDLUM MODEL 3 SURVEY MTR

Well Development Form
Juniper Uranium Mine

Date 9/30/04 – 10/1/04
Sampling Team MDU/GPM

Well Number MW 1
Total Depth 247
Screen Length 40

Well Location JUNIPER
Initial Depth to Water 191.81
Casing Volume 26 gal

Final Depth to Water ~246'
Casing and Filter Pack Volume 105

~1220 START Time	Cumulative Volume	Pumping Rate	pH	Conductivity	ORP	Temperature	Turbidity	FERROUS IRON
1328	~60 GALS*	~0.5 gal/min	8.06	0.554	234 mV	8.98	OS; BROWNISH GRAY–OPAQUE	NA; OPAQUE
~1455	~75 GALS	WELL ~~BAIL~~ BAILED DRY.						
1523	~75+	NA	8.41	0.575	188	~~7.87~~ 8.25	OS; BROWNISH GRAY	Ø

* INCLUDES ~30 gals from 9/30/04 BAIL CLEAN-OUT & SURGE

Observations

Well Sampling Form
Juniper Uranium Mine

Date 9/30/04
Sampling Team MDU/GPM

Well Number MW 1
Total Depth 247' (TOC)

Well Location JUNIPER
Depth to Water 240.43'

Well Developed? YES
Sampling Rate ~1 gal/min

Time	pH (at end of sampling)	Conductivity	ORP	Temperature	Turbidity	FERROUS IRON
1841	8.49	0.563 mS/cm	177	6.63	OS	Ø
1848 *	8.45	0.549	184	6.41	OS	Ø

Analytical Methods	Uranium, Thorium, and CLP Metals	Iso-U, Iso-Th, Pb-210, P0-210	Ra-226	Alkalinity, NO3/NO2, PO4, Cl, SO4	TSS, TDS
Containers	Acidified 500 ml Poly	Acidified 4 L Cube	Acidified 1 L poly	1 L poly	1 L poly
Sample ID Filtered					
Sample ID Unfiltered					

Observations

USED TEFLON TO SAMPLE ; SAMPLE TIME 183Ø ; TURBIDITY RESULTING FROM FINES (SILT TO CLAY)

* LAST 3.5' OF WATER IN WELL

Well Development Form
Juniper Uranium Mine

37.52' ~~gal~~ AFTER CLEAN-OUT & SURGING 40 GALS REMOVED
= (81.4')(0.65)

Date 10/1/04
Sampling Team MDU/GPM

Well Number MW-2
Total Depth 92.84' (TOC)
Screen Length 40'

Well Location JUNIPER
Initial Depth to Water 11.42'
Casing Volume 53gal
* STICK-UP = 2.5'

Final Depth to Water ~
Casing and Filter Pack Volume ~~127~~ ~~164~~ ~~(60)(2.5) + (244)(.65)~~ 124gal ~~150~~ ~~+ 13.2~~
81.4' COLUMN OF H_2O
= (60)(2.5) - (40)(0.65)
= 150 - 26

Time	Cumulative Volume	Pumping Rate	pH	Conductivity	ORP	Temperature	Turbidity	FERROUS IRON
1255	40 Gals	2 gal/min	6.90	1.355	254	10.10	390	0
1313	~70	1.75 "	7.15	1.258	211	9.07	950	0
1329	95 gals.							
1340	112.75 → WATER LEVEL BELOW PUMP INLET (PUMP 2' OFF BOTTOM)					1.75gal/20min =		
1400	RESTART PUMP – 1.3gal/min#		– REMOVED 1.75GALS		∴ ~~ONLY RECOVERED @ 0.1 GP~~	0.088gal/min		Recharge rate
1401	114.5	1.3gal/min	7.65	1.464	228	10.17	26	0
1420	RESTART PUMP		– REMOVED 1.5 gals					
1423	116	NA	7.65	1.422	207	10.26	21	

20MIN RECHARGE PERIODS

Observations *1.75 gals IN 1 min. 21 secs. ; WATER APPEARS VERY CLEAR

TOTAL PURGED AFTER RECOVERY = 12 L + 4.5 Gal, ~~≈ 29L = 7.67 gal~~
= 12 L + 17.4 L = 29.4 L ⇒ 7.60 gal
7.60 gal / 0.65 gal/ft = 11.68 ft

11.68 ft + 2 ft = 13.68'
(pump inlet 2' of bottom)
∴ DTW = 92.84 − 13.68
= 79.15'

Well Sampling Form
Juniper Uranium Mine

Date 10/1/04
Sampling Team MOU/GPM

Well Number MW-2
Total Depth 92.84' (TOC)

Well Location JUNIPER
Depth to Water 79.15'

Well Developed? YES
Sampling Rate 0.5 GAL/min

Time	pH	Conductivity	ORP	Temperature	Turbidity
1405	7.80	1.207 mS/cm	207	9.75	3.9

FERROUS IRON
0

Analytical Methods	Uranium, Thorium, and CLP Metals	Iso-U, Iso-Th, Pb-210, P0-210	Ra-226	Alkalinity, NO3/NO2, PO4, Cl, SO4	TSS, TDS
Containers	Acidified 1L ~~500 ml~~ Poly	Acidified 4 L Cube	Acidified 1 L poly	1 L poly	1 L poly
Sample ID Filtered					
Sample ID Unfiltered					

Observations

Recovery @ 17:15 85.91
17:36 84.55

Waste Rock Pile No.2 Survey Line No. WR2-AA

Start GPS 700089.001 2062434.531 meters

End GPS 700054.288 2062424.005

MID GPS N/A

Short line east of line A in wider area of pile (North end)

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
AA-1	0			165	165
AA-2	40			315	285
AA-3	80			290	265
AA-4	120			240	240

Start over edge

Survey Date 6/24/04 Personnel MDU/GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PRR / MODEL 3 SURVEY METER W/ 44-2 NaI Detector

S/N 124304 S/N PR130739

FAST RESPONSE / NEW BATTERIES

- NUMEROUS 500-1000 uR/hr ~~areas~~ AREAS ASSOCIATED W/ LOW-GRADE ORE ON MID TO SOUTH END OF WR2 (ALSO APPEARS TO BE DIFF. ERA OF MINING/WR IS ORANGE/BROWN COLOR)
- NUMEROUS 300-500 uR/hr ~~areas~~ AREAS ASSOCIATED W/ LOW-GRADE ORE ON MID TO NORTH END OF WR2
- HUMMOCKY AREA BETWEEN LINES B & H & LAST FOUR (3 POINT FOR A & B) POINTS OF EACH LINES

40x40 grid
Max of 150 nodes

Waste Rock Pile No.2 Survey Line No. WR2-A

oriented N-S parallel to edge ~~(east side)~~ of Line B → 20 east of Line B

Start GPS 7ØØØ79.15Ø 2Ø62425.454
End GPS 6Ø9951.954 2Ø62385.416 meters
* MID GPS 7ØØØØ9.233 2Ø624Ø4.Ø81

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start WR2A-1	Ø			18Ø	2Ø5
A-2	40			345	3ØØ
A-3	80			16Ø	195
A-4	120			3Ø5	265
A-5	160			34Ø	28Ø
A-6	200			25Ø	225
A-7 *	240			165	165
A-8	280			135	135
A-9	320			145	155
A-10	360			165	18Ø
A-11	400			175	175
A-12	440			85	90

Survey Date 6/24/04 Personnel GPM/MDO
GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PRO XL

Waste Rock Pile No.2 Survey Line No. WR2-B

Start GPS 700081.020 2062420.118

End GPS ~~699945.985~~ ~~2062377.279~~ 699951.108 2062379.696 meters

*MID GPS 700009.461 2062398.920

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start WR2-B-~~1~~ 2	~~0~~ 40			200	195
B-~~2~~ 3	~~40~~ 80			430	305
B-~~3~~ 4	~~80~~ 120			270	225
B-~~4~~ 5	~~120~~ 160			240	245
B-~~5~~ 6	~~160~~ 200			205	160
B-~~6~~ 7*	~~200~~ 240			285	230
B-~~7~~ 8	~~240~~ 280			195	165
B-~~8~~ 9	~~280~~ 320			190	175
B-~~9~~ 10	~~320~~ 360			155	200
B-~~10~~ 11	~~360~~ 400			200	230
B-~~11~~ 12	~~400~~ 440			260	245
~~B-12 13~~	~~440 480~~			~~100~~	~~115~~
B-1	0			165	165

Survey Date 6/24/04 Personnel MDU/GPM

GPS Datum NAD83 CSP ZONE 3 Equipment TRIMBLE PROXL

Waste Rock Pile No.2 Survey Line No. WR2-C
Start GPS 700071.391 2062404.676
End GPS 699941.990 2062363.630 meters
MID GPS* 700012.111 2062387.176

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start WR2-C-1	0			160	165
C-2	40			180	175
C-3	80			275	275
C-4	120			155	160
C-5	160			125	150
C-6*	200			205	230
C-7	240			315	295
C-8	280			295	275
C-9	320			340	345
C-10	360			330	410
C-11	400			600	490
C-12	440			95	100
~~C-13~~					

Survey Date 6/24/04 Personnel MDU/ GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PROXR

Waste Rock Pile No.2 Survey Line No. WRZ-D
Start GPS 700062.015 ~~206289.676~~ 2062389.676
End GPS 699944.546 2062351.424 meters
MID GPS* 700014.918 2062375.220

	Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start	WRZD-1	0			215	175
	D-2	40			195	205
	D-3	80			190	155
	D-4	120			150	150
	D-5*	160			340	295
	D-6	200			340	310
	D-7	240			375	305
	D-8	280			550	500
	D-11	400			100	120
	D-~~10~~ 9	320			950	900
	D-~~11~~ 10	360			490	550
	END					

Survey Date 6/24/04 Personnel MDU /GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PROXR

Waste Rock Pile No.2 Survey Line No. WR2-E

Start GPS 700052.530 2062374.434

End GPS 699947.245 2062339.642 meters

*MID GPS 700017.483 2062363.144

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start WR2-E-1	0			185	180
E-2	40			110	130
E-3	80			265	305
E-4*	120			375	335
E-5	160			600	440
E-6	200			525	485
E-7	240			245	400
E-10	360			155	155
E-10 8	280			725	725
E-11 9	320			600	485
10					

Survey Date 6/24/04 Personnel MDU / GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PROXR

Waste Rock Pile No.2 Survey Line No. WR2-F

Start GPS 700041.994 2062358.700

End GPS 699950.050 2062329.856 meters

* MID GPS 700024.766 2062351.517 —(@ 2'N)

	Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start	WR2-F-1	0			300	210
	F-2	40			425	375
	F-3*	80			315	300
	F-4	120			345	325
	F-5	160			480	425
	~~F-6~~	~~200~~ e GPM				
	~~F-7~~	~~240~~ e				
	F - 9	320			355	205
	GPM e F-~~9~~ 6	200			1025	900
	F ~~10~~-~~10~~ 7	240			1300	750
	F ~~11~~ 8 e GPM	280			245	190

Survey Date 6/24/04 Personnel MDU/GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PROXR

Waste Rock Pile No.2 Survey Line No. WR2-G

Start GPS 7ØØ Ø32.ØØ1 2Ø62343.3Ø8 meters

End GPS 699 952.641 2Ø62316.6Ø1

* MID GPS NA NA (SEE START 40' N)

	Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start	WR2-G-1	Ø			24Ø	215
	G-2*	40			15Ø	16Ø
	G-3	80			4Ø5	3ØØ
	G-4	120			6ØØ	625
	~~G-5~~	~~160~~				
	~~G-6~~	~~200~~				
	~~G-7~~	~~240~~ GPM				
	G-8	28Ø			12Ø	115
	G-~~9~~ 5	16Ø			85Ø	7ØØ
	G-~~1Ø~~ 6	2ØØ			1425	95Ø
	G-~~11~~ 7 GPM	24Ø			475	345

Survey Date 6/24/04 Personnel MDU/GPM

GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PRO XL

Waste Rock Pile No.2 Survey Line No. WR2-H

Start GPS 700024.075 2062327.720 meters

End GPS 699967.270 2062308.620

MID GPS N/A

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start WR2-H-1	0			75	90
H-2	40			130	125
H-3	80			235	215
~~H-4~~	~~120e~~				
~~H-5~~	~~160~~ GPM				
~~H-6~~	~~200e~~				
~~H-7~~ GPM					
H-~~9~~ 4	120			410	390
H-~~10~~ 5	160			650	500
H-~~11~~ 6 GPM	200			150	160

Survey Date 6/24/04

GPS Datum NAD 83 CSP ZONE 3

Personnel GPM/MIDU

Equipment TRIBLE PROXR

Waste Rock Pile No.2 Survey Line No. WR2 - I
Start GPS 700004.262 2062308.999
End GPS 699970.629 2062296.483 meters
MID GPS N/A

Point Number	Distance from End	Northing	Easting	Surface (uR/hr)	3 foot (uR/hr)
Start WR2 - I - 1	0			95	125
I - 2	40			200	200
I - 3	80			115	115
I - 4	120			125	125
~~I - 5~~	~~160~~ e Alm				

Survey Date 6/24/04 Personnel MDU/GPM
GPS Datum NAD 83 CSP ZONE 3 Equipment TRIMBLE PRO XR

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location ~~06/30/04~~ WR3-1-S ~~-C~~ GPM

Sample/Measurement Date 06/30/04

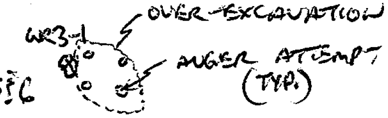
Sampling Team MTW / GPM

Time	Sample Number	Sample Depth ~~(ft bgs)~~	Grab?	Northing	Easting	Metals	Rad µR/hr	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1150	WR3-1-S	6"-12"	Y				18					
1320	WR3-1-S	13"-19"	Y				18					
1330	WR3-1-S	20"-26"	Y				19					
1335	06/30/04-WR3-1-S-C		N				—					

REFUSAL BASED ON PICKAXE LIMITATIONS BGS.

Observations/NOTES: FOUR (4) SEPARATE AUGERHOLES REFUSED @ 12" TO 18" BGS. THE 6"-12" COMPOSITE PORTION WAS COLLECT W/ THE HAND AUGER. A PICKAXE & SHOVEL WERE USED TO OVER EXCAVATE THE AUGERHOLES IN ATTEMPT TO GET THRU ~~THE~~ ROCKS. ROCKS / GRAVELS PERSITENT TO ≈26". 13"-19" COMPOSITE PORTION TAKEN FROM SIDEWALL. 20"-26" TAKEN FROM BASE OF EXCAVATION. EACH OF THE EQUAL AMOUNTS WERE RAD SCREENED INDIVIDUALLY (SMALL BOWL) THEN ADDED TO LARGE BOWL FOR MIXING & SAMPLE COLLECTION.

SEE PHOTOS JUNIPER#2; 5 & 6



(LT. RAIN DURING COLLECTION)

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location ~~06/30/04~~ WR3-2-~~S-C~~ GPM

Sample/Measurement Date 06/30/04

Sampling Team GPM / MTW

Time	Sample Number	Sample Depth (ft bgs)	Grab?	Northing	Easting	Metals	Rad uR/hr	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1420	WR3-2-S	6"-12"	Y				18					
1440	WR3-2-S	13"-19"	Y				17					
1450	WR3-2-S	28"-34"	Y				18					
1455	06/30/04-WR3-2-S-C		N				—					

Observations COLLECTED BY SIMILAR MEANS AS WR3-1 AS SUBSURFACE CONDITIONS WERE SIMILAR

(LT. RAIN DURING COLLECTION)

SEE PHOTOS JUNIPER #2, 3 & 4

JUNIPER MINE
SAMPLING AND OBSERVATION SHEET

Sampling/Measurement Location: WR3-3
Sample/Measurement Date: 06/30/04
Sampling Team: MTW / GPM

Time	Sample Number	Sample Depth (ft bgs)	Grab?	Northing	Easting	Metals	Rad μR/hr	WET Metals	WET Rad	Anions	Alk	TSS/ TDS
1715	WR3-2-S	6"-12"	Y				18					
1730	WR3-2-S	19"-25"	Y				16					
~~1845~~	MW WR3-2-S	28"-34"	Y				16					
1815												
1815	06/30/04-WR3-3-	S-C	N				—					

Observations: COLLECTED BY MEANS SIMILAR TO WR3-1 (HAND AUGER REFUSAL @ 12" BGS, OVER EXCAVATED USING PICK & SHOVEL)

SEE PHOTOS, JUNIPER 2, NO 2.

APPENDIX C
FIELD PHOTOGRAPHS

APPENDIX D

HUMAN HEALTH AND ECOLOGICAL RISK SCREENING METHODOLOGY

APPENDIX D
RISK SCREENING METHODOLOGY

The risk screening consisted of comparing concentrations of contaminants at Juniper Mine with appropriate risk benchmarks. Human health and ecological risk screening benchmarks were obtained or developed for evaluation of the chemicals of potential concern (COPC) at Juniper Mine. Because most of the metals at the site are radionuclides, development of appropriate benchmarks was required.

D.1 HUMAN HEALTH RISK SCREENING METHODOLOGY

Human health risk benchmarks for non-radioactive metals were obtained from the U.S. Environmental Protection Agency (EPA) Region IX preliminary remediation goals (PRG) (EPA 2004) for an industrial exposure scenario (soil and sediment), calculation of PRGs for a site-specific recreational exposure scenario (soil and sediment), EPA ambient water quality criteria (surface water), California Toxics Rule criteria (surface water), promulgated maximum contaminant levels (MCL) (surface and groundwater) (EPA 2004), and calculated MCLs for radionuclides (surface water and groundwater).

Most human health soil radionuclide benchmarks were developed after the EPA "Soil Screening Guidance for Radionuclides: Users Guide" (EPA 2000) using an on-line calculator at the following web address: risk.lsd.ornl.gov/rad_start.shtml. Human health benchmarks were developed assuming a recreational visitor exposure scenario for Juniper Mine. This scenario conservatively assumes that a recreational visitor accesses Juniper Mine twice a week for 6 months a year (52 days per year) for 10 years. This is considered to represent a very conservative exposure scenario because access to this part of the high Sierra is limited to less than 6 months. Also, the site is not a designated recreational area, is not advertised as such, and provides no recreational or other support services that might encourage ongoing recreational use.

Exposure pathways considered in developing soil screening levels include ingestion, dermal contact, and inhalation of resuspended soil particulates. In the case of the radionuclides, the dermal exposure pathway is not relevant and was not considered. Instead, the external irradiation pathway was included in the evaluation for radionuclides. Inhalation of radiation from water not calculated because the exposure pathway is incomplete (no residences with showers exist or are

planned). Risk from each exposure pathway was summed to develop a cumulative risk at each sample location. In general, external irradiation was the most important exposure pathway. External irradiation at Juniper Mine is caused by gamma emission from the decay of radium-226; therefore, reduction of radium-226 in soil will reduce gamma emission.

Assumptions used in the development of soil and sediment screening levels for radionuclides using the on-line calculator are summarized below for each exposure pathway.

External Irradiation

Exposure frequency: 52 days per year	ETi: 0.86
Exposure duration: 10 years	GSF: 0.4
Area Concentration Factor: 1.0	GSF: 0.4
ETo: 0.073	

Soil and Sediment Ingestion

Exposure frequency: 52 days per year	Adult Exposure Duration: 4 years
Exposure duration: 10 years	Soil Intake: 100 mg/day (adult); 200 mg/day (child); 160 mg/day (age adjusted)
Child Exposure Duration: 6 years	Sediment: 50 mg/day (adult); 100 mg/day (child); 80 mg/day (age adjusted)

Dust Inhalation

Climate: Zone IV (Casper, WY)	ETo: 0.073
Area: 14 Acres	ETi: 0.86
Q/C: 41.65	Exposure frequency: 52 days per year
Vegetative Cover: 0.4	Exposure duration: 10 years
Um: 4.69 m/s	T: 10 years
Ut: 11.32 m/s	F(x): 0.194
IRi: 20	DFi: 0.4

EPA's "Soil Screening Guidance for Radionuclides: Users Guide" (EPA 2000) does not consider radon generation in its guideline methodology, therefore a separate computer model, Residual Radioactivity (RESRAD) (Yu et al. 2001), was required to address radon emissions to the ambient air due to radium-226 in the mine pit and waste rock. Radon is the radioactive decay product of radium-226. RESRAD is currently the most widely accepted modeling software used to evaluate environmental sites contaminated with radionuclides. RESRAD was used to calculate an ambient concentration of radon based on the maximum concentration of radium-226 detected in the mine pit and waste rock.

In general, EPA Region IX industrial PRGs were used to assess carcinogenic and non-carcinogenic risk associated with non-radionuclide metals in soil and sediment. A recreational PRG was also developed to address carcinogenic risk associated with arsenic and non-carcinogenic risk associated with total uranium in the mine pit and waste rock. These PRGs were developed by modifying the industrial PRG developed by EPA Region IX (EPA 2004) to reflect a recreational exposure scenario as described above. EPA Region IX considers dermal and inhalation exposure to uranium to be negligible, so the recreational PRG is based only on soil ingestion exposure. Based on the assumptions above and an incidental soil ingestion rate of 100 milligram per day (mg/day) a recreational PRG of 1,064 milligram per kilogram (mg/kg) total uranium was developed. This PRG is based on the noncarcinogenic toxicity of uranium. For arsenic, the ingestion, inhalation, and dermal exposure pathways were used to develop a recreational PRG of 3.04 mg/kg based on the carcinogenic toxicity of arsenic.

In general, EPA Region IX industrial PRGs were used to assess carcinogenic and non-carcinogenic risk associated with non-radionuclide metals in soil and sediment. A uranium and arsenic sediment benchmark was also developed based on the recreational visitor assumptions described above. Due to the lack of information regarding rates of sediment ingestion, it is typically assumed that the rate of sediment ingestion is the same as the rate of soil ingestion. However, this is overly conservative because the creek at Juniper Mine is not particularly suited for water recreation activities. It was therefore assumed that the sediment ingestion rate (50 mg/day) was only one-half the soil ingestion rate (100 mg/day), resulting in a sediment benchmark for total uranium of 2,130 mg/kg and 5.21 mg/kg for arsenic. As in the case of the benchmarks for soil, the uranium benchmark is based on noncarcinogenic toxicity while the arsenic benchmark is based on carcinogenic toxicity.

Promulgated MCLs for uranium, radium-226, arsenic, and cadmium were used as benchmarks for surface and groundwater. MCLs were calculated for radionuclides based on the following assumptions: EPA carcinogenic slope factors for radionuclides, an ingestion rate of 2 liters per day, for 52 days per year, over a 10 year period of exposure. MCLs were calculated based on a lifetime cancer risk of 1E-06.

D.2 ECOLOGICAL RISK SCREENING METHODOLOGY

Ecological risk benchmarks for non-radioactive metals were obtained from EPA ambient water quality criteria for protection of aquatic life, California Toxics Rule criteria for protection of aquatic life, and technical reports developed by Oak Ridge National Laboratory (Efroymson et al. 1997). Ecological risk screening benchmarks for radionuclides in soil, surface water and sediment were obtained from the recently published Department of Energy (DOE) methodology "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2002); from "Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at Oak Ridge National Laboratory, Oak Ridge, Tennessee" (Bechtel Jacobs Company [BJC] 1998); from "Toxicological Benchmarks for Wildlife: 1996 Revision." (Sample et al 1996); from "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision." (Jones et al 1997); and from "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision" (Suter et al 1996).

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APPENDIX E

RESRAD RADON GAS MODELING RESULTS